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ACCIDENTS TO FLY WHEELS.

The discussion we print in this issue on the cause of accidents to fly wheels in power stations furnishes the most important contribution to the general subject of fly wheel accidents that has, we believe, even appeared in a technical journal. All of the engineers who take part are well qualified to write on the subject. One is recognized, not only in this country but in Europe, as the leading authority on the design of fly wheels, while at least one other is a similarly recognized authority on the theory of engine design and the properties of engineering materials. As will be seen, the concensus of opinion is that, while a sudden load thrown on a generator is not without danger, yet destructive strains are rather to be ascribed to centrifugal than to tangential stress; there is also substantial agreement that defectively designed or inoperative governors are the usual active causes of accidents. The most important conclusions to be drawn from the discussion are that cast-iron fly wheels are engineering absurdities, and that the engine governor is probably the most important piece of apparatus in a power house and should receive corresponding attention.

REACTANCE.

Last week we called attention to a criticism by Prof. Blondel of Paris, on the definition reactance as given in Messrs. Steinmetz & Bedell's paper, published in our issue of June 30th. The electrical system of units and terms is the most perfect and the most international of all those in other branches of science and engineering, and it is therefore of great importance to keep it at the head of the list by having perfect agreement on all points pertaining to the system. In order to give all an opportunity to discuss this subject of reactance, we give in this issue a complete translation of Prof. Blondel's article, accompanied by a very able discussion by Messrs. Houston and Kennelly on the points raised. We hope the subject may be thoroughly ventilated and that the discussion will bring about a uniform use of this important term in this country and abroad. In reply to Prof. Blondel's remark that due credit had not been given the Société Internationale des Electriciens for having originally suggested this word, we desire to call attention to the fact that in the article on this term in our issue of May 26, page 712, we, at least, acknowledged that the term originated with that society.

AN ELECTRIC STREET RAILWAY NUMBER.

As a recognition of the importance of the meeting in convention of the American Street Railway Association at Atlanta during the present week, The Electrical World devotes the greater part of this issue to subjects relating to electric traction. Believing that the professional benefit of those connected with the electric street railway industry can be better served on this occasion than by printing a general tourist's guide to the convention city and surrounding country, or perfunctory articles with no technical value, we present instead a budget of matter whose value is not of such a transient character. The article on the Atlanta street railways furnishes in concise form the most exhaustive account of the important points relating to this extensive system that has as yet been published. The articles by Prof. Hermann S. Hering on the vast system of the Philadelphia Traction Company, will describe in detail the various engineering features of what constitutes the finest example of modern electric railway engineering in this country, which is equivalent to saying, in the world. Lieut. Cahoon and Mr. George T. Hanchett ably deal with the no less important points of operation and management, and the discussion on fly wheel accidents in power stations furnishes the most valuable contribution to the subject ever made.

STANDING LOADS ON RAILWAYS.

In a discussion in London on the Liverpool electric railway, a Mr. O. F. Nichols stated that "American lines encouraged standing loads" on railways. We suggest that the word "lines" should have been underscored, as it is the companies and not the people who "encourage" it. On some German railways there is a fourth-class, in which ordinary cattle cars are used with nothing but a few posts to hold on to; the chief difference between this system and ours, however, is that there, respectable people are not compelled to ride in that way, but they may do so if they prefer, the price being only half as much as the second-class fare. When high speed, such as is proposed by some enthusiasts, is introduced, then standing loads, or better, hanging loads, will naturally be "encouraged" by the people, and there will then be a real advantage in standing or holding on to the straps, as those who are fortunate enough to get hold of a strap will then swing freely like a pendulum, while those unfortunate enough to get a seat will, owing to the laws of centrifugal force, be tossed about like a foot ball in the old style game, in which it was the ball and not the players that was kicked about. When that time comes, the German lines may charge an increased fare for the privilege of standing up.

LIGHT FROM CITY REFUSE.

We are pleased to see that the much talked of scheme for utilizing the energy residing in a city's refuse and converting it into electric light, is about to be put into practical operation in the historical little town of Ealing, in England, where Huxley was born, where Thackeray, Edward Bulwer Lytton and other famous writers went to school and where Dickens often visited. Suggestions on paper are cheap, as they cost merely the paper and the ink, and it is therefore not surprising that much has been written on this fascinating subject, but what is really wanted to further the introduction of such apparently reasonable methods, is an actual test, from the records of which reliable data can be obtained. The results of this not unwarranted municipal enterprise will be waited with great interest. It appears that the oragnic refuse of this town is now being destroyed by fire, generating steam which is used for pumping works, and it therefore only requires an extension of the present system to utilize the steam also for generating electric light. One of the difficulties in utilizing refuse will, it seems, be oevrcome by mixing some coal with the refuse. Another important feature is that the refuse must be burnt at a high heat in order that it may not give off offensive odors and to accomplish this there should be complete combustion in the boiler before heat is abstracted from the gas. The town is not large, having a population of only 27,000 and only a portion of it will be supplied, with 5,000 lamps of 8 candle-power. The experiment, although not on a large scale, is still sufficiently so to give results on which similar installations can be based. We do not doubt that it will be a success, as the refuse must be destroyed in some way; the only question is whether the economy will be sufficient to warrant the cost, or if it is cheaper to do each separately.

ILLUMINATION.

In the science of photometry there is only one unit at present in use, the candle-power, and with this much-abused, ill-defined, unsatisfactory unit, writers on photometric subjects have tried to express no less than five different quantities. This branch of physics, so important to electrical engineers, is therefore sorely in need of attention and it is important that the electrical engineers and physicists take up the subject before photographers introduce special units and terms which would not be the best for the whole subject in general. A very good beginning at systematizing photometric units was recently made by Prof. Blondel, as was shown in the Digest in the issue of August 11. While this is an excellent beginning, his system is not quite perfect and we call attention to it again in order that it may be fully discussed before the terms he proposes have become too well established. One point which we think will be a very serious drawback to the adoption of this system, by English speaking countries at least, is that he uses the French word "illumination" for a totally different quantity than that for which the English term illumination is used. The new French term is the product of what is known in English as illumination by the factor time, and corresponds to what photograph's call "exposure." It seems to us very important that one of these terms should be changed or else there will be a continual confusion between them. As the English term is already too deeply rooted in the science to be changed now, and as the French term is new, it is not unreasonable to ask the French to change their term, which, by the way, is also badly chosen for other reasons. To call it "exposure" would not be advisable, as that term is special to photography and has no meaning outside of that field. As there is no objection to using several words, we suggest the term "duration of illumination," as that explains itself, it being the product of the duration or time and an illumination. "Quantity of illumination" corresponding in its derivation with that of another term "quantity of light" (candle-power multiplied by time), is another name that might be used, but we think that the term "duration," which itself implies the "time" element, is preferable to "quantity," which does not necessarily carry with it the idea of time. For the same reason we recommend changing Prof. Blondel's last term "quantity of light," that is, the candle-power of a light multiplied by the time during which it lasts, into "duration of light," or still better and in accordance with the suggestion of Mr. Hospitalier, simply "lighting." It is this unit by which light would be measured in commerce if it is paid for, as it should be, according to the candle-power and the number of hours during which the lamp burns.

ELECTRIC RAILROADS.

Some good papers on the Liverpool elevated electric railway, were recently read and discussed, abstracts of which appeared in these columns. The conclusion to which every unbiassed person must now come, after giving the matter due thought, is that this, the first permanent elevated railway operated entirely by electricity, is a perfect success; not that it could not have been better, but that as it stands it is a success. This pioneer line ought to convince those who, although recognizing surface electric traction as a success, still had doubts about the application of electricity to an elevated line. Arguments to show why electric traction should be better than steam are no longer required, as they have frequently been given, but what remained was to really show by an actual case that the arguments were correct. One of the most striking proofs, at least to the capitalist, is that the original contract for the Liverpool line required the contractors to operate the road at a certain fixed price per train mile for a certain time, which price was evidently considered a fair one; but after running awhile the company found that the contractors were making too much money and it decided to relieve them of this obligation long before the stated term had expired. What better proofs could a capitalist want? And this on a pioneer elevated road. Among other things which are noticed in our columns and which show that decided progress is being made in the direction of heavier electric traction, are that a French railroad company is at present building 60 locomotives for driving 800 tons at 15 miles an hour. Also that chief engineer Parsons, after making an exhaustive study of European city railways, reported to the Rapid Transit Commission of New York, that steam would be intolerable in an underground railway, and that with a speedy, frequent service an underground road can be operated successfully and economically by electricity. It is now quite safe to predict that no more elevated or underground city railways will be built to run by steam locomotives. An underground electric road is now being built in Budapest, an overhead line in Berlin, while Vienna and Paris are both consideirng the construction of underground electric roads, and in London the extension of the existing underground electric line, the pioneer of its kind, to run east and west through London, is likely. In connection with surface lines we give a brief description of a surface sectional conductor system, which has been running successfully for some months in Lyons, although we believe that this particular system is too complicated for general introducion.

Concerning Reactance.*

BY ANDRÉ BLONDEL.

The fact is known, although attempts have recently been made to ignore it, that the term "reactance" was first officially proposed by the Societe Internationale des Electricians, at its session of June 6, 1893, in conformity with the report of the committee it appointed to examine the proposals for the Chicago Congres . This convenient term, which has since been adopted by this journal, was advantageous in terminating the confusion introduced by the ambiguous use of the term "inductance," and also, for the first time, enabled the analogous but opposing effects produced in a circuit by self-induction and capacity to be united under a single name.

It was not surprising, therefore, that the term rapidly found favor abroad, and that it was recently adopted by the American Institute of Electrical Engineers, which is always distinguished for its progressive tendencies. There is reason to fear, however, that the acceptation now given to the word "reactance" across the Atlantic, extends somewhat beyond that which its originators desired to give it, and I believe that it is desirable to point out the intended misapplication, in order to place French electricians on their guard against the errors that may result in consequence.

In defining reactance, the French committee proposed to give a name to the effect of the virtual resistance produced by self-induction, or by capacity, or by both combined, in an alternating current circuit.

If E be the effective E. M. F., I the effective current strength produced, and R the ohmic resistance, the current can always be expressed in the form

$$I = \frac{E}{\sqrt{R^2 + K^2}},$$

the denominator being what is known as impedance. The term K is called the reactance. In the particular case where the current follows a simple harmonic law

$$K = \left(\omega L - \frac{1}{\omega C}\right).$$

L being the inductance (or coefficient of self-induction), C the capacity, and $\omega = \frac{2\pi}{T}$ the pulsation of the current.

Thus defined, reactance is a constant of the circuit for a given frequency, of the same nature as its resistance (the same quantity being formerly called the inductive resistance).

In my judgment, it is precisely because it is a constant, that the reactance has a claim to independent title; for by that reason it permits the numerical definition of alternating current circuits to be completed whose ohmic resistance is insufficient to characterize them, and to predict the phenomena which will be produced under the influence of one or more definite E. M. F's.

Two American authors, who desired to generalize the definition of the Societe Internationale, have recently published a new conception of it, diametrically opposite in character, and which has unfortunately been everywhere reproduced without protest.

They state in a manner which does not appear to admit of any possibility for dissent: "Reactance is equal to the reactive E. M. F., that is, to the component of the total E. M. F., which is in quadrature with the current, divided by the strength of the current. Reactive electromotive forces are set up in alternating current circuits by self-induction, mutual induction, capacity, or by outside counter E. M. F.'s, such as those of synchronous motors;" and again, as an application to the case of a transformer. "The counter E. M. F. (produced by the secondary) can be decomposed into two others, one in phase with, and the other in quadrature with the current. The first gives a power E. M. F., the second a reactive E. M. F. The counter E. M. F. of a motor can be treated in the same way." From this point of view, reactance is no longer a constant of a circuit; it varies according to circumstances, being a complex and heterogeneous combination of all kinds of reaction, of which several do not exist save under the influence of neighboring circuits. It is therefore no more than a new name applied to phenomena better defined in other ways.

This is, I believe, an unfortunate conception, which can give rise to much misunderstanding. Thus we are informed that the component of an E. M. F. in quadrature is the product of the current and the reactance. How then about the component in phase? Everyone would suppose, after reading the paper referred to, that it is equal to the product of the current and the ohmic resistance, which is not the case. If this error is to be avoided it will be necessary to define a new quantity, which would be the quotient of the E. M. F. in phase with the current by the current strength. But an absurd complication would thus be brought about, and all the more useless, since the quantities whose names terminate in *ance* would be variable.

How much more satisfactory, on the other hand, is the conception of reactance as a constant property of a circuit. If this be isolated, the current which traverses it depends only upon the impedance and upon the applied E. M. F. If it includes a synchronous motor, it will be sufficient to take for this E. M. F. the resultant of all the active E. M. F's. This greatly simplifies the theory of alternating current motors. If a transformer be introduced, both primary and secondary circuits will have definite resistances and reactances, and the effect of the reaction of the secondary will be equivalent to an apparent modification, not only of the reactance of the primary, but also at the same time of its ohmic resistance.

It is needless to add that it will be sometimes desirable to decompose E. M. F's into two components. This is sometimes useful. In general the inverse operation is often more effective, i.e., the decomposition of the current into two components: the active current, and the inactive current (German wattstrom and wattloserstrom). In every case, however, this decomposition has no reason to be extended to the definition of reactance.

Conclusion: Reactance, like all words terminationg in *ance*, should serve to define a single constant in a circuit. It need not then apply to any but the effects of inductance and capacity in the circuit. I believe it is undesirable to adopt in France a new definition. If it be desired to represent the effects of mutual induction or of outside E. M. F's. by a quantity analogous to this constant from the standpoint of effects produced, it would be well to specify explicitly that an *apparent* "reactance" is dealt with; that is to say, a purely fictive quantity having no real existence.

*From *L'Industrie Electrique*, September 25, 1894.

On the Definition of the Term Reactance.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

We notice on p. 416, Vol. III, No. 66, of "L'Industrie Electrique" for September 25, 1894, an article by M. A. Blondel entitled "Apropos de la Reactance" and in which the author calls into question the use of the term reactance as applied in America, and contrasts this use with that suggested by its original authors in France.

Briefly, the history of this term is as follows: In No. 33 of "L'Industrie Electrique" appearing on May 10, 1893, p. 207, M. Hospitalier discusses the subject of symbols and notations for physical quantities. He suggests that the term reactance should be applied to the expression denoted by K, in the equation for harmonic currents,

$$I = \frac{E}{\sqrt{R^2 + K^2}}$$

In the June number, 1893, of the Bulletin of the Société Internationale des Electricians, in the report of the Committee appointed by the Société to formulate a discussion upon the Congress proposals of the American Institute of Electrical Engineers, the following sentence appears:

"The Committee proposes that a name should be given to the quantity whose square added to the square of the resistance in the circuit traversed by a periodic current, gives the square of its apparent resistance. The name reactance could be applied to this quantity."

At its Philadelphia meeting this year, the American Institute of Electrical Engineers adopted the term "reactance" for "the ratio" in "alternating current circuits of the quadrature component of E. M. F. to the current." (Transactions A. I. E. E., Vol. XI, No. 6, June, 1894, p. 327.)

This is a quantity whose square added to the square of the resistance in an alternating current circuit is the square of the impedance, except when mutual induction is operative.

If an alternating current circuit possessing resistance, inductance, and capacity, has an E. M. F. with any wave type,—simple harmonic, or complex,—of, say, 1,000 volts effective, and the current in the circuit is 2 amperes, then the impedance of the circuit under any conditions is 500 ohms. Further, if the circuit be electrically isolated, so that no mutual induction exists between it and other circuits, and if the resistance of the circuit, as measured by a continuous current, is 300 ohms, then the reactance of the circuit will be 400 ohms. This would be the amount of reactance under the proposed definition of the Société Internationale, or under the

definition adopted by the American Institute, and in this sense the term seems to have been applied with the same significance by Blondel and Hospitalier in France, Silvanus P. Thompson, in England, and Steinmetz and Bedell in America. When, however, mutual inductance exists, as, for example, when transformers are included in the circuit with loaded secondaries, the reactance, by definition of the Amerlican Institute, differs from that which M. Blondel desires to see adopted, and also from that proposed by the Société Internationale; for, the practical effect of loading the secondary circuits is to reduce the quadrature component of reactive E. M. F., and to bring the impressed E. M. F. and the current more closely into phase. The reactance of the circuit by the American Institute definition, therefore differs from its isolated reactance. M. Blondel considers that this is a misconception, that the reactance of the circuit should be its isolated reactance, and a constant for that circuit, like its inductance, or resistance. He intimates that such was the intention of those who first suggested the word, the ending of which, *ance*, is usually associated with fixed quantiites of matter depending on form. It is only fair to point out, however, that the degree of fixedness of reactance in a circuit, is, in any event, considerably less than that of resistance or inductance; for, neglecting temperature effects, these are constant for all commercial frequencies, while reactance varies, even in an isolated circuit, with the frequency of alternation, and with the wave type of E. M. F.

Seeing that no confusion exists between the definition of the Société Internationale, or the American Institute, or M. Blondel, upon the meaning of reactance when referring to isolated circuits, all confusion can be avoided by specifying "equivalent reactance," and "equivalent resistance" for the particular cases of mutally inductive circuits. In that event, the product of the square of the current and the equivalent resistance ($I^2 R'$) will be the rate of expending energy in a mutually inductive circuit, while the product of the square of the current and the resistance ($I^2 R$) will be the rate of expending energy in an isolated alternating or continuous current circuit.

By the use of this phraseology, not only will the objections of our French co-workers be apparently overcome, but no violence will be done to the definition adopted by the American Institute.

Laboratory of Houston and Kennelly, Philadelphia.

Alternate Current Working—VII.

BY HARRIS J. RYAN.

The following four examples are given for the purpose of making a study of the simple effects of the presence of capacity in electric circuits. In the first of these, see Fig. 23, current from a source of pressure at A is established through a condenser K in series with a non-inductive resistance R.

$E_A = 500$ volts at 125 p. p. s.,
$R = 117$ ohms,
$K = 10$ microfarads.

The impedance for ohmic resistance and capacity is

$$\frac{E}{C} = \sqrt{R^2 + \frac{1}{K^2 \omega^2}}$$

$$C = \frac{500}{\sqrt{117^2 + \frac{1}{(10 \times 10^{-6} \times 2\pi \times 125)^2}}}$$

$C = 2.87$ amperes.

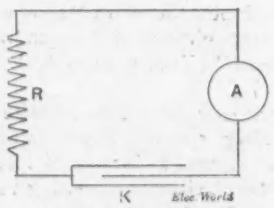


FIG. 23.

In the next example (see Fig. 24) we want to know what capacity must be used to balance the inductance of the field of a shunt motor. The applied pressure is 100 volts at 125 p. p. s., the resistance of the field is 200 ohms, number of field turns 4,250, field induction 300,000 lines. L, for a circuit that contains 4,250 turns about an induction of 300,000 lines produced by a current of .5 amperes, is determined in the following manner:

$$B = \frac{E}{1.4\pi\, a\, t\, \sim} \quad B\, a = M$$

$$E = M\, 1.4\pi\, t \sim = L\, \omega\, C$$

$$L = \frac{M\, 1.4\pi\, t \sim}{\omega\, C} =$$

$$L = \frac{300{,}000 \times 1.4\pi \times 4{,}250 \times 125 \times 10^{-8}}{2\pi\, 125 \times .5}$$

$L = 17.8$ henrys.

$E_L = 17.8 \times 785 \times .5 = 7{,}000.$ volts

It was determined that when $L\omega = \frac{1}{K\omega}$ in any circuit, the opposing capacity and induction E. M. F.'s will balance, whence

$$K = \frac{1}{L\,\omega^2} = \frac{1 \times 10^6}{17.8 \times 785^2}$$

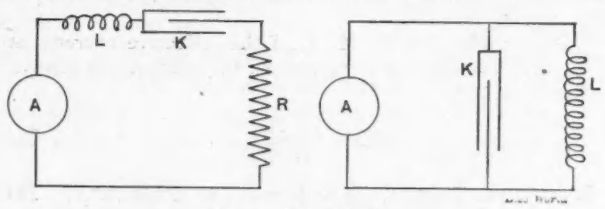
$K = .09$ microfarads.

The pressure that the field current of .5 amperes will develop in passing through the condenser is determined from the relation

$$C = E\, K\, \omega \times 10^{-6}$$

$$E = \frac{.5}{.09 \times 785} = 7000.$$ volts.

Likewise the pressure developed in the field circuit by the field induction is $E = CL\omega = .5 \times 17.8 \times 785 = 7{,}000$ volts. The capacity and induction E. M. F.'s are equal and opposite, so that current is established through the circuit just as though they were absent so long as the insulation of the circuit and condenser is good and sufficient to stand the 7,000 volts. It will be remembered that the capacity E. M. F. is 90 degrees behind and induction E. M. F. 90 degrees ahead of the alternating current. Motors of this class for which this example applies are at present still in the experimental stage.



FIGS. 24 AND 25.

In the diagram of Fig. 25 the condenser is used in parallel with an apparatus that possesses inductance, such as the "hedgehog" transformer with secondary on open circuit. Current is supplied by A at a pressure of 1,000 volts at 125 p. p. s. The induction current that is established through the primary of the transformer with the secondary on open circuit has been measured and found to be one ampere. When studying the phenomena of induction and capacity it was noted that the induction and capacity current are exactly opposed to one another when they produce the same E. M. Fs. Here we want to know what capacity must be used so that the induction and capacity currents will be equal and opposite and the line current reduced to zero. The reactance E. M. F. of K is 1,000 volts.

$$E_K = \frac{C_K}{K\,\omega} = 1000 \text{ volts.}$$

Now the current L equals one ampere, the current through K must, therefore, be one ampere, whence

$$\frac{1}{K \times 10^{-6} \times 785} = 1{,}000.$$

$K = 1.235$ microfarads.

In practice one would not in general realize exactly all the conditions that are necessary to attain an exact balance of this sort.

(To be continued).

Electricity and the Whitewashing Trade.

Painters and whitewashers will not be pleased to hear the statement of Mr. Whiteley, an Englishman, that he saves $2,500 a year in less paint and whitewash by using the electric light. The Painters' and Whitewashers' Union in this country will probably proceed at once to boycott any one who dares to use the electric light; a little thought and science, however, will show them that a fresh coat of whitewash in factories and other like places will often save more than its cost in the reduction of the amount of electric light required.

ELECTRIC SYSTEM OF THE PHILADELPHIA TRACTION COMPANY

BY HERMANN S. HERING.

The Philadelphia Traction Company was the first of the street railway companies in Philadelphia to change its motive power from horses to electricity. Two years ago there was the most strenuous opposition to the introduction of the trolley system into Philadelphia, when this company applied for the privilege. Mass meetings were held, petitions were circulated, councilmen were threatened and every effort made by the people to prevent this "invasion of the deadly trolley." The Philadelphia Traction Company, however, fought long and hard and finally, by means of a loop-hole in the charter of the Catharine and Bainbridge Streets line, and through their promises to build the road in the safest and best manner possible, and pave the streets from curb to curb, succeeded in obtaining the right to equip and operate this line by electricity. It was to be a "model road" and show the people of Philadelphia what a good trolley road was, most of those who objected never having seen one. The feeders were all to be placed underground, the trolley wire protected from wires falling across it by means of guard wires, neat iron poles were to be used, the street paved with asphalt from curb to curb, the cars stopped at every street crossing and on the near side, to avoid accidents, and every precaution taken to further the successful operation of the road.

The experiment was a thorough success and broke the ice of opposition, and since then permission has been granted to this company for the electrical equipment of all of its lines, and to the other street car companies as well, and within two years, between 100 and 200 miles of trolley roads have been laid and operated in Philadelphia, or about to be started, and most of this has been done within the past year. A contrast to the strong opposition of the people two years ago, was shown during the opening of a road with this new equipment recently.* The first cars were greeted by the shouts of hundreds of people, who lined the route and gave vent to their enthusisam with fireworks and brass bands; banners were displayed with such phrases as "Welcome Rapid Transit," etc., and the officials who occupied the first car were showered with flowers by the ladies along the road.

All of the car lines which have been equipped for electric traction have been obliged to follow the general plan of the first and so called "model road," embodying underground feeders, iron poles, guard wires, and a new pavement from curb to curb of either asphalt or belgian block, according to the requirements of the Department of Public Works of the City Government. Thus Philadelphia is being equipped with trolley roads of the safest and best character, and is also enjoying the benefits of newly paved streets, a great contrast to the historic cobble stones. This was undoubtedly due, to a large extent, to the determined opposition which the railway companies had to overcome, as experience in other cities shows that the street car companies do not pave the streets and put the feeders underground of their own volition. Most of the franchises are very valuable, however, and the city is entitled to some return therefrom. By putting in a first-class equipment at the outset the companies will be the gainers in the end, as the operation is thus more satisfactory and more economical and the item of repairs small.

The rapidity and thoroughness with which the roads of the Philadelphia Traction Company have been equipped and the stations constructed, and the success with which they have been operated from the start, reflect great credit upon the management of the company, but especially upon the skill and perseverance of the enigneering staff, to whose ability and conscientious efforts this success is mainly due.

The officers of the Company are as follows: President, P. A. B. Widener; first Vice-President, W. L. Elkins; second Vice-President, G. D. Widener; Secretary and Treasurer, D. W. Dickson; General Manager, J. T. Gorman; Electric Engineer, F. Uhlenhaut; Jr., and they are well known as among the most progressive railway men in the country.

GENERAL.

The Philadelphia Traction Company operates at present about 119 miles of equivalent single track road, electrically, 34 miles by means of cables, and 25 miles by horses, making a total of 178 miles. It contemplates equipping all of its present lines with electricity and building new lines into the suburbs as soon as possible, reaching a total mileage eventually of about 300.

The complete cost per mile, not including the power stations, has been about $30,000 and this company has spent several millions already in the electrical equipment and will spend a million or two more.

The map in Fig. 1 shows the electric roads of the company in operation and in *immediate* contemplation, representing about 116 miles of single track and 37 miles of double track or a total of 190 miles of equivalent single track, which is 12 miles more than the total mileage they operate at present. The system extends from the eastern to the western limits and from the northern to the southern portion, and reaches nearly all of the important parts of the city and, with one exception, is the most extensive electric system operated by one company in the world, and is the first large system to use underground feeders.

The power is generated in four stations, as shown on the map. Station A, at Sutherland avenue and Kansas streets feeding the southern portion of the city, which was the first one started; station B, at 13th and Mt. Vernon Streets feeding the central portion, and the second one started; station C, at 33rd and Market Streets, feeding West Philadelphia, and station D, 32nd and Dauphin Streets, which is nearing completion and is to feed the lines in the northern part of the city. These stations aggregate at present about 11,550-hp and have an ultimate capacity of 19,800-hp.

Table I. contains the principal dimensions of these stations and the approximate number of cars operated by them at present, though this number will be increased considerably in a short time.

Table II. contains a list of the various roads in operation with their lengths, number of cars operated on each, and other data—23.79 miles of single track and 15.66 miles of double track will be operated electricaly in a month or two, comprising one of the old cable lines, and some of the horse car lines in West Philadelphia and in the northern section.

THE POWER STATIONS.

23d and Sutherland Ave.—Station A.

This was the first of the various stations being built for the Catharine and Bainbridge Streets line, the "model" road, and as there was some doubt about how the experiment with trolleys in Philadelphia would turn out, this station was not built on an extensive plan, but was so arranged that an annex could readily be constructed. The building of this annex is nearly completed and some of the new machinery will soon be running. Fig. 2 shows a view of the exterior of this station; the one in the foreground is the original building, and the one at the back, the addition.

The dimensions of the original building were as follows: Engine-house 72′x66′ and boiler-house 72′x64′, both being about 36′ high: those of the addition are; Engine-house 115′x53′ 6″ boiler-house 130′x45″ and both about 35 feet high.

The boiler equipment originally consisted of six 150-hp Wetherill steam tubular boilers, 72″x20′, and there has been an addition of ten 125-hp boilers of the same kind 60″x20′. Natural draft is used; the original stack, which is of sheet iron with a brick base and made by the Convery Boiler Company of Philadelpiha is 6′6″ diameter and 135 feet high, and the stack for the additional boilers is 10 feet diameter, and 175 feet high The piping is arranged so that any boiler can be connected to any engine. Chapman valves and 12 inch mains are used. The steam pressure is 125 pounds.

The boilers are fed by means of two Worthington duplex pumps 8x6x10 inches, and two No. 10 Monitor Injectors.

The original engine equipment consists of three 250-hp Wetherill engines, cylinder 22″x48″; 75 revolutions per minute; each belted to a 250-hp. Westinghouse 4 pole high speed generator, 525 revolutions per minute. The engine pulley is 18 feet in diameter, 31″ face, and of the generator is 31″ diameter. A 36″

*See Philadelphia *Public Ledger*, Sept. 27th, 1894.

idler is used as belt tightener and to increase the contact. The new equipment at present consists of two 750-hp Wetherill-Corliss engines, cross compound, condensing. These engines are directly coupled to a 750-hp Westinghouse multipolar generator of the new type, and are used non-condensing but are arranged to be used condensing if desired. There will be either another 750-hp or else a 1,500-hp machine put in during the coming year.

Two 100-hp Westinghouse compound engines drive the blowers; they are at present on the floor of the boiler house and belt upwards, but they will be removed to a platform under the blowers in order to gain additional floor space.

Fig. 5 is a view of one end of the boiler room, looking in from the street. This shows five boilers on each side, the coal hoppers in the middle and the blowers in the background.

TABLE I.—CAPACITY OF THE POWER STATIONS.

Stations.	Floor Space.		Boilers.			Engines.			Generators.			Cars Oper'd at present.
	Boiler Room.	Engine Room.	Make.	Present H. P.	Ultimate H. P.	Make.	Present H. P.	Ultimate H. P.	Make.	Present H. P.	Ultimate H. P.	
A Sutherland Ave.....	10,458	10,904	Wetherill.	2,150	2,150	Wetherill.	2,250	2,250	Westinghouse,	2,250	2,250	52
B 13th & Mt. Vernon Sts.	13,700	14,280	Babcock & Wilcox. Double-Deck.	3,750	7,500	Westinghouse. Wetherill.	3,000 3,000 6,000	3,000 6,000 9,000	Westinghouse.	6,000	9.000	270
C 33d & Market Sts.....	11,637	11,784	Babcock & Wilcox. Double-Deck.	3,000	6,000	Westinghouse. Wetherill.	1,800 1,500 3,300	1,800 4,500 6,300	Westinghouse.	3,300	6,300	70
D 32d & Dauphin Sts.... (Not in operation.)	7,029	7,029	Wetherill. "Berry."	....	2,000	Wetherill.	.....	2,250	Westinghouse.	.....	2,250	....
	42,824	43,997		8,900	17,650		11,550	19,800		11.550	19,800	392

TABLE II.—CAR ROUTES AT PRESENT IN OPERATION.

Name of Road.	Length of Single Track (Miles).	Length of Double Track (Miles).	Approximate Number of Cars Operated.	Station from which Operated.	Time Interval Between Cars (Minutes).	Date of Starting Up Road.
Catherine and Bainbridge Sts.....	5.5	1.	18	Station A	3	Dec. 15, 1892
Morris and Tasker Sts..	5.9	..	14	Station A	4	Sept. 21, 1892
19th and 20th Sts.....	6.0	..	20	Station A	3½	July 31, 1894
13th and 15th Sts.....	12 0	..	72	Station B	2½	Dec. 16, 1893
12th and 16th Sts.....	10.0	..	58	Station B	2½	Jan. 12, 1894
Ridge Avenue.....	....	3.3	36	Station B	2½	April 9, 1894
Manayunk.....	....	3.75	9	Station B	6	July 1, 1894
17th and 19th Sts.....	11.25	..	33	Station B	3¼	Aug. 29, 1894
22d and Allegheny Sts..	1.75	4.0	12	Station B	....	Nov. 1, 1894
Spruce and Pine Sts....	8.75	..	20	Station B	3½	Oct. 22, 1894
Chestnut & Walnut Sts.	3.7	2.0	40	Stas. B&C	3½	July 12, 1894
Philadelphia and Darby	....	4.7	9	Station C	6	June 23, 1894
Lancaster Avenue.....	3.7	2.3	35	Station C	3½	May 29, 1894
49th & Woodland Ave..	3.7	2.4	16	Station C	5½	Sept, 22, 1894
Totals	72.25	23.45	392			

13th and Mt. Vernon Sts..—Station B.

This station was the second one constructed and is the largest of all. The engine, dynamo and boiler rooms are located at the northeast corner of 13th and Mt. Vernon streets, a general plan of which is shown in Fig. 3, and a view of the exterior of this, as well as the Mt. Vernon street end of the boiler house is shown in Fig. 4. The Mt. Vernon street front, which is 100 ft. long, is built in three floors, 21 ft. wide, in which are the offices of the engineering staff, the draughting room and testing room. Back of them and extending along 13th street is the engine and dynamo room, which is 146′ 5″ long, 97′ 6″ wide, and 60 ft. high. The boiler house is 169′ 6″x80′ 10″ and about 60 ft. high, and contains at present 10,375 hp Babcock & Wilcox double-deck boilers, and has room for 10 more, 5 of which are now being installed. The boilers are arranged on opposite sides of a 20 ft. passageway in batteries of five, another passage, also 20 ft. wide, crossing this and leading to a side street. Over this passageway the economizers are located, and at the crossing of the two passageways are the blowers and stacks. Induced draft is produced by four Sturtevant blowers, one for each battery, and placed between the economizer and the stacks. There are two iron stacks, one for each side of the boiler house, but placed together in the center over the blowers. They are 10′ 6″ in diameter and the top is 27 ft. above the blowers and 70 ft. above the grates. There is a flue leading from each battery of boilers to an economizer and then to a blower. The two blowers of the boilers on one side, exhaust into a common stack.

There are two ash tunnels, 7 ft. wide and 7 ft. 8 in. high, running the entire length of the building, one under each row of boilers. Ash hoppers under each boiler extend into this tunnel and thus the ashes are readily removed.

The water supply at present is from the city mains, but an artesian well is being bored from which an ample supply is anticipated. The well is to be 8″ in diameter and 200 ft. deep;

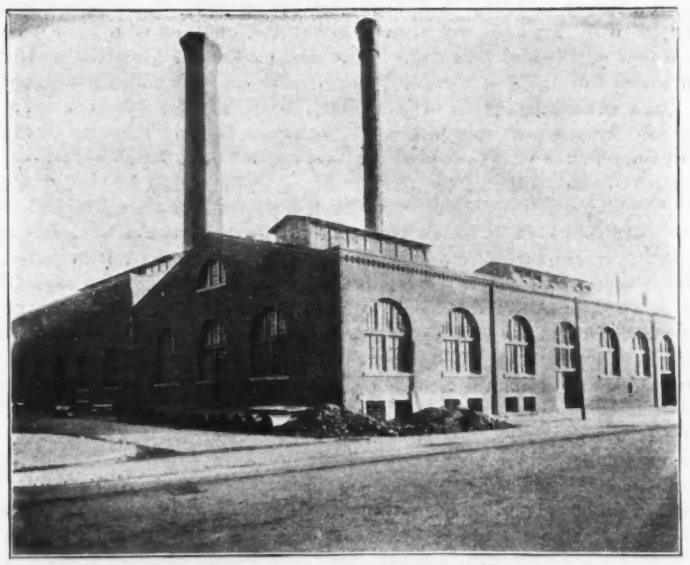


Fig. 2.—Exterior of Station A, Sutherland Avenue.

it was begun in September, 1893, and is estimated to be completed in June, 1895. An 8″ water main leading from the city mains is used at present. Two Worthington Compound Duplex pumps are used for the feed water and they are connected to the 8″ main as well as to two storage tanks of a capacity of 63,246 gallons. These pumps have steam cylinders 12 and 18½ inches in diameter and 10¼ inch plunger, with a 10-inch stroke, and are capable of delivering form 530 to 890 gallons per minute. The feed water is heated by four 2,500-hp Goubert heaters, placed in the engine exhaust, which raise the temperature to betwen 125° F. and 200° F., and also by four Green Economizers which raise the temperature about 70° more. These are both rather unusually large sized heaters but they are working very well and giving perfect satisfaction. The feed water circuit is from the street main and tank, through the pumps, exhaust heater and economizers to the boilers. Hercules oil injectors are used on the exhaust of each pump to supply oil to

the feed water and thus prevent scale. 150° kerosene is used, and about 6 gallons are fed in about 24 hours for 2,000 hp. It is being tried as an experiment, and has worked successfully so far. Each boiler is equipped with a "Korting No. 14 injector connected to the street main, by way of precaution.

elevating conveyor and taken to the coal hoppers under the roof, and over the fire room. Large iron pipes lead from the hopper to the floor of the fire room, and the supply can be regulated by the fireman. Two 35-hp Westinghouse compound engines drive the conveyor, and there is an emergency conveyor in the center of the

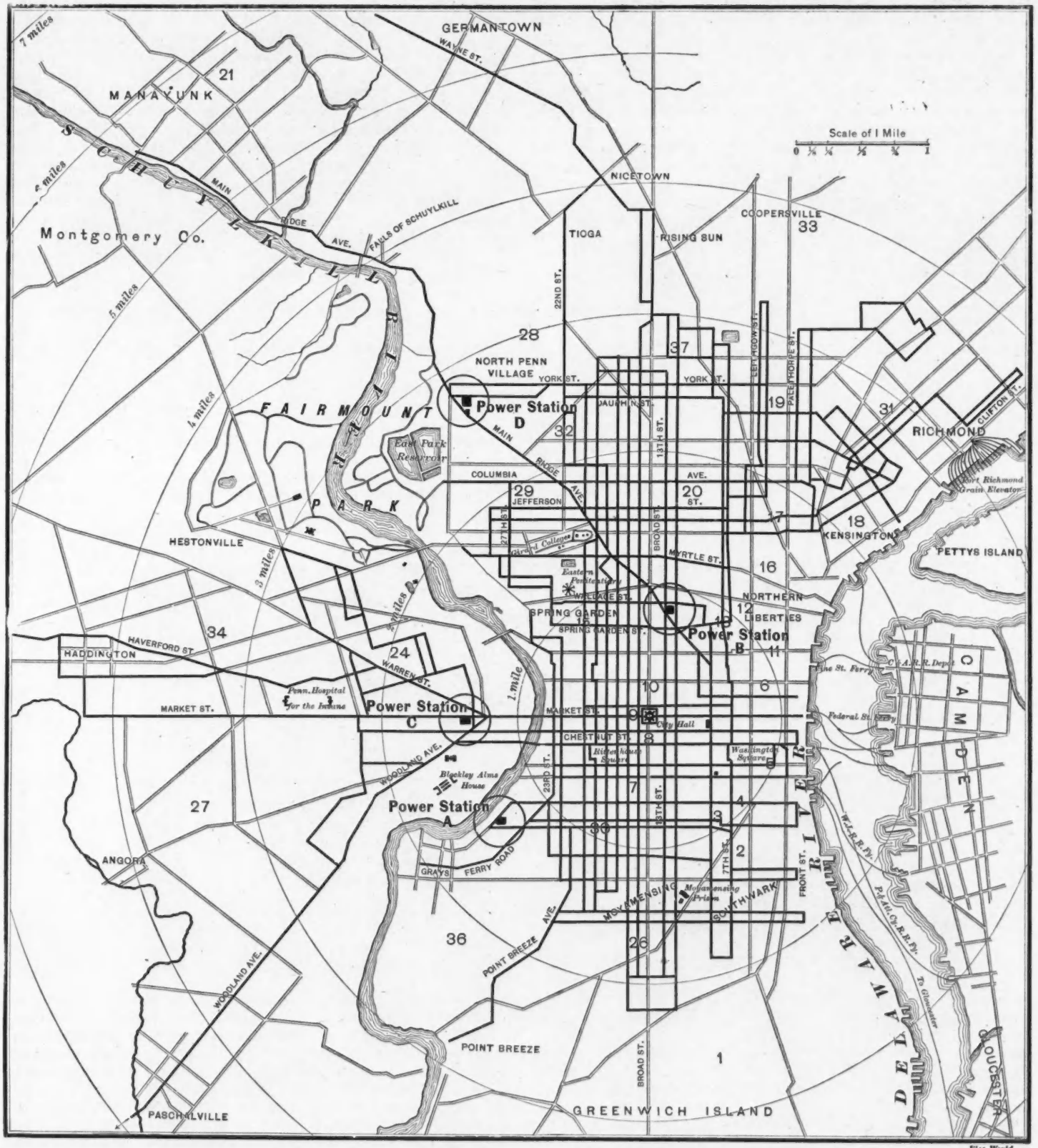


FIG. 1.—ELECTRIC RAILWAY SYSTEM, PHILADELPHIA TRACTION COMPANY.

The coal conveyor supplied by the Link Belt Engineering Company, is a very extensive one. The coal is delivered at a side door, where it is weighed and dropped into a trough from which it falls into the horizontal spiral conveyor which takes it along the basement to the vertical conveyor. There it is dumped into the boiler room. The storage capacity is about 400 tons. Tupper grate bars are used in the furnaces and they are spoken of as giving good results.

There is a special blow-off tank for the boilers, and all the drips are collected in a well, before running off to the sewer.

There is nothing of special interest about the piping, except possibly the large reverse bend copper expansion joint, placed in the leads from the boilers to the main. There are five of these and they are 10 in. in diameter, 5-16 in. thick, 10′ 6″ long and have a radius of 3 ft. 6 in.

Anthracite pea coal is used and at present about 60 tons a day are consumed, three firemen and two cleaners being at work continuously. The steam pressure in the boilers is kept at 140 pounds.

Fig. 6 is a view of the interior of the engine room, showing about 60 per cent. of the power equipment. In the front are two of the 1,500-hp Wetherill engines and Westinghouse generators; back of these the five "Kodaks," and extending along the south and partly along the west wall, is the Switchboard.

The equipment consists at present of 5 Westinghouse vertical automatic compound engines, each directly coupled to Westinghouse four pole generators, located in a row at the south end of the building. These engines are rated at 600-hp with 140 pounds initial pressure and a speed of 215 revolutions, but are now running at about 120 pound initial pressure and 205 revolutions per minute. The cylinders are 23″ and 40″ in diameter and the stroke is 20 inches. They are what have been popularly called the "Kodak" type, and middle and 18″ at the bearings and is made of cast open hearth steel. The bearings are made extra heavy and all precautions taken in the design and construction to make the entire machine as serviceable for railway work as is possible. These engines, as well as the 750-hp machine in the other stations were built by Robert Wetherill & Co., Chester, Pa.

This generator is of the same type as that exhibited by the Westinghouse Company at the World's Fair, and those supplied for this station are the first machines of this size that have ever been run. Six of them have been ordered by the Philadelphia Traction Company; four for this station and one each for the Sutherland and Market street stations.. This generator has 10 poles placed radially on a circular yoke 12′ 6″ outside diameter. The armature is 90″ and the commutator 60″ in diameter.

The engine-room is equipped with a 10-ton and a 20-ton Sellers crane, one of which is equipped with electric propulsion and the other with hand propulsion apparatus, but both have hand hoists. These cranes are also shown in Fig. 6. Two immense Stratton separators, the largest ever built, are placed in the steam mains and have a capacity of from 4,000 to 5,000,-hp each. The piping is all in the basement except the leads to the engines, which have 8 ft. risers and a semi-circular copper expansion joint forming the connection

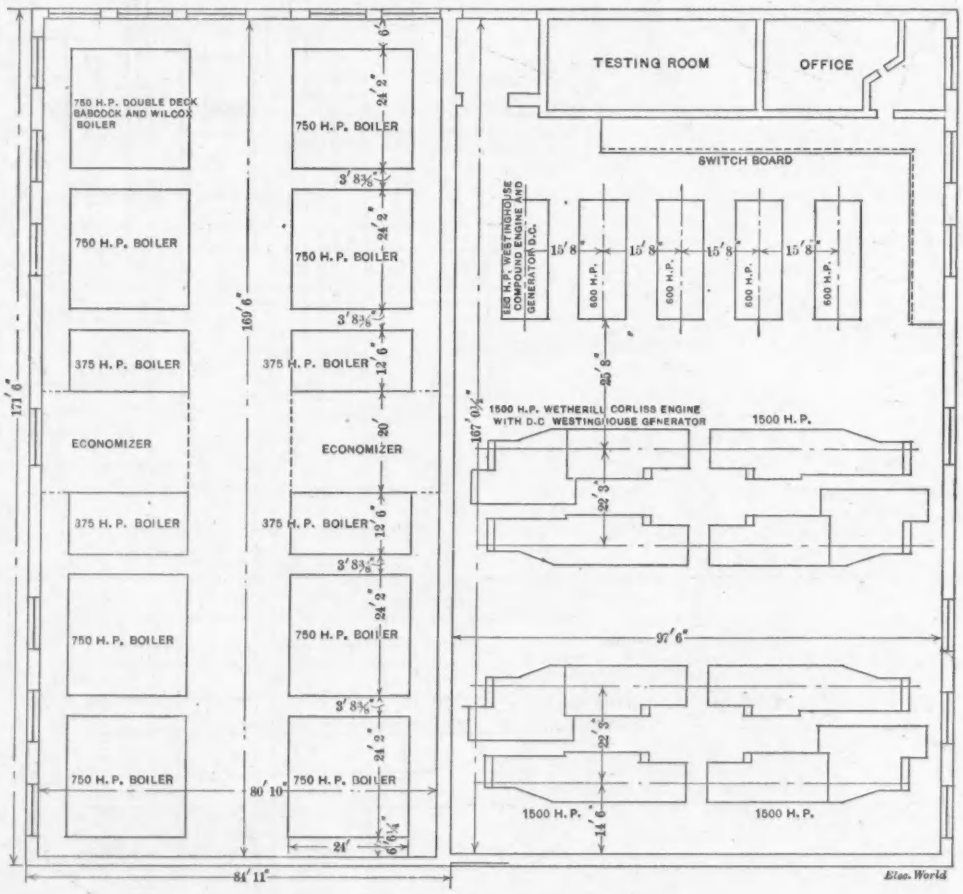


FIG. 3.—PLAN OF MT. VERNON POWER HOUSE.

have given very little trouble so far, as they are given every attention by very competent engineers who have charge of them. These engines are thrown on or off according to the load, but the average operation is about as follows: One engine runs 24 hours, one 22 hours, one 20 hours, one 16 hours and one five hours. They alternate on different days, so that each engine runs about the same number of hours.

The rest of the equipment is eventually to consist of four 1,500 h. p. machines, but at present only two are installed, one of which is running and the other about to start. Two of these machines are shown on Fig. 6.

The engines are Wetherill Corliss twin tandem compound enignes and the generator is placed between them on a continuous shaft. The cylinders are 26″ and 40″ in diameter; the stroke 48 inches; and the speed 80 revolutions per minute. They are rated at 1,500-hp at 135 pounds initial pressure. The twin engines are 22′ 3″ between centres. The fly wheel is 21 ft. in diameter and its rim weighs 100,000 pounds, being made especially heavy to steady the speed under the variable load. The shaft has a diameter of 21 7-8″ at the from the riser to the throttle, which are also partly shown in Fig. 6. The oil-circulating pumps of the Westinghouse engines have been recently equipped with oil and water separators to prevent water from being pumped instead of oil, which sometimes happened formerly, but is now entirely avoided. The plant is equipped with 24-inch Lyman exhaust heads.

The switchboard extends along the south wall for 62 ft. and along the west wall 34, making a total of 96 ft. At present it controls about 100 feeders, but its ultimate capacity is 250. Fig. 7 is a view of this switch-board, and also the row of "Kodaks" shown in the background of Fig. 6. The lower panels contain the switches, etc., of the generators, and the main feeder switches, and the upper panel the individual feeder switches, meters etc. The connections are practically the same as for railway switch-boards in general, namely, on the generator panels, a main triple pole, double throw switch, connecting the positive, negative and equalizing leads from the generators to the two sets of positive, negative and equalizing bus bars behind the panels. The ammeter and circuit breaker are connected between the switch and the generator on the negative lead.

Below the switch is a voltmeter plug, which is connected to the leads of the machine, and also a field rheostat. The principal use for the double sets of bus bars, is that one of them may be kept at a higher voltage, for distant points; they can also be used in case of accident to the others.

The main positive bus bars are connected through eight 4,000 ampere

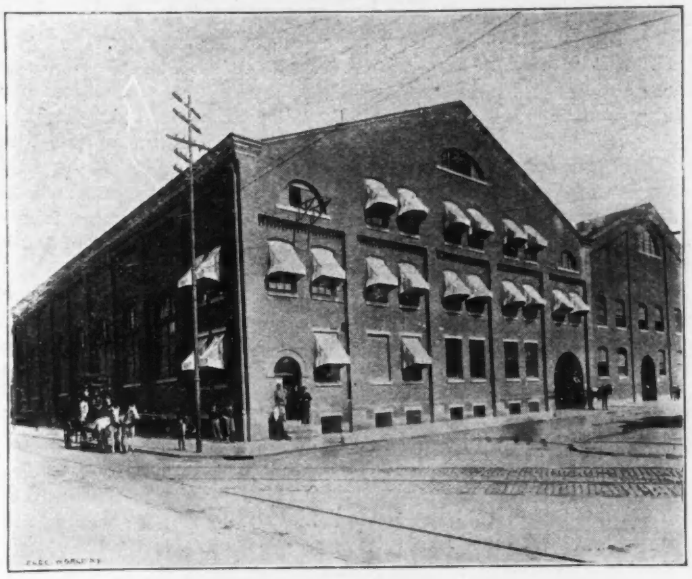


FIG. 4.—EXTERIOR OF STATION B, MT. VERNON STREET.

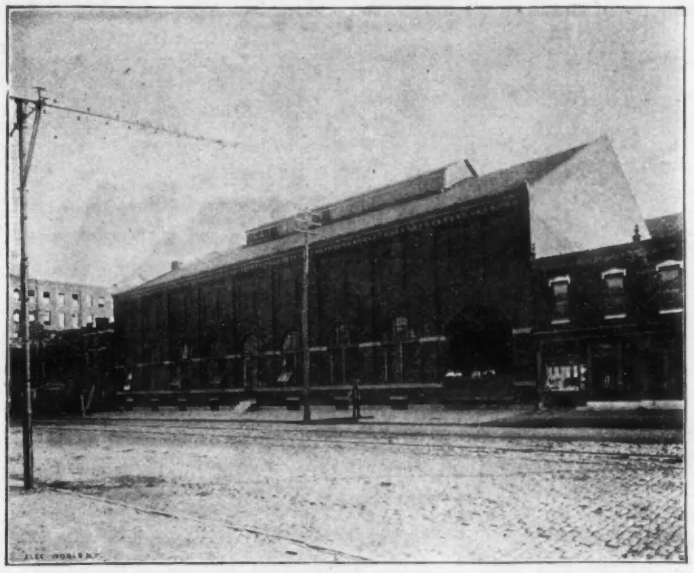


FIG. 9.—EXTERIOR OF STATION C, MARKET STREET.

switches and ammeters to the feeder bus bars from which the taps are made for the individual feeders. The panels of the individual feeders contain a single pole, double-throw switch, one upper and one lower terminal being connected with taps on the two bus bars; and the middle terminal with the circuit breaker, ammeter and lightning arrester and feeder cable. Fig. 8 shows the connections of a few panels of the switch-board at 13th and Mt. Vernon streets, except that they omit the main feeder switches between generator and feeder bus bars. Weston ammeters are used on all the switch boards of this company.

The negative bus bars are connected with the return feeders and also with the earth. The bus bars are mostly 3″ copper bars, 21 feet long, supported on insulation and tapped by means of split collars which are clamped on. The switch-board is constructed of an iron framework, into which slate panels are set and the instruments fastened on these. The switch boards of this station, as well as some of the others, were built by Andrew H. Haig, a well-known engineer and machinest of Philadelphia.

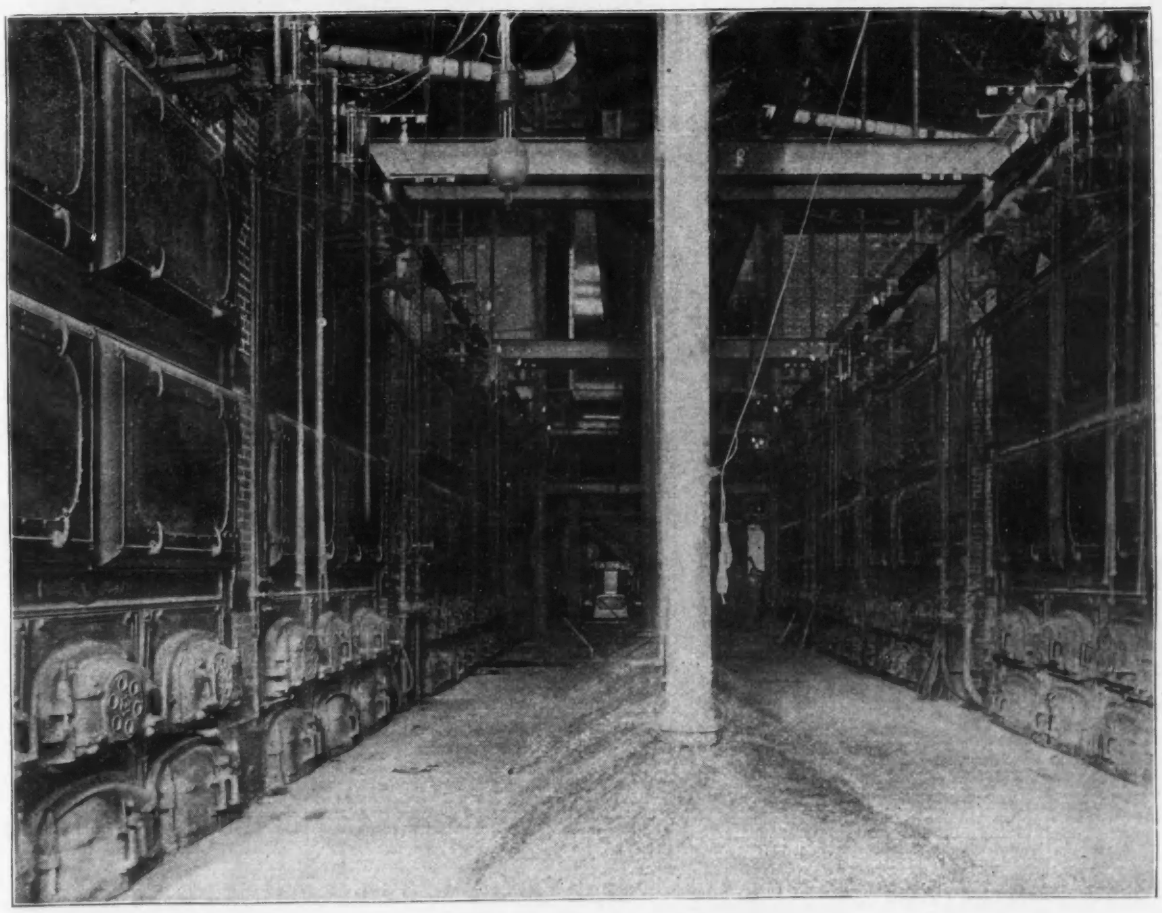


FIG. 5.—BOILER ROOM OF MT. VERNON STATION.

33d and Market Sts.—Station C.

This station feeds all the lines west of the Schuylkill River, and was the third one constructed. In a general way it resembles the station at 13th and Mt. Vernon streets, most of the apparatus being duplicated. Fig. 9 gives a view of the exterior.

The boiler room, which is 147″ 4½″ x 79′, is equipped at present with 8-375-hp Babcock and Wilcox double-deck boilers, the ultimate capacity of the house being 16 in all, in batteries of four, eight

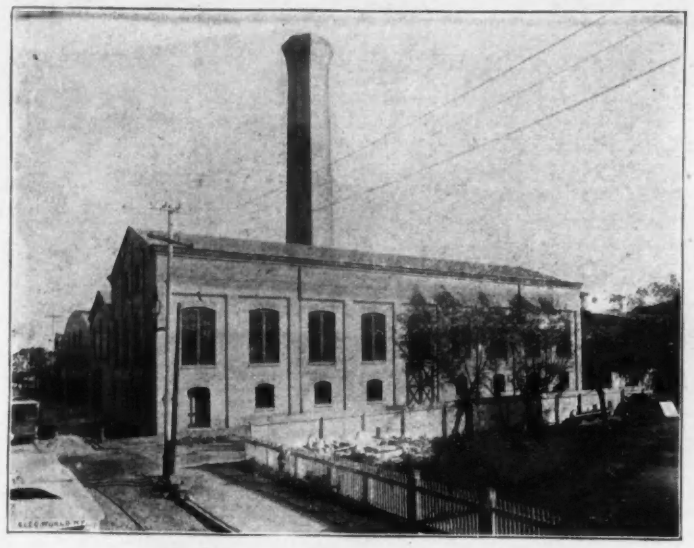


Fig. 10.—Exterior of Station D, Dauphin Street.

being placed on opposite sides of a passage way. Two of them are equipped with Cox stokers by way of experiment.

The boilers are independently connected to two 8″ and two 16″ pipes, with bi-passes, valves, etc., to render the system as flexible as possible. Induced draft is used in this station and the arrangements are similar to those at 13th and Mt. Vernon streets; namely, 4 Sturtevant blowers, 4 Green economizers and 2 Goubert heaters. The bi-pass valves are 20″ Fairbanks, which are among the largest high pressure valves ever made. The Link-Belt Coal conveyor is also similar, except that the coal storage is outside of the building; the ashes are also handled in practically the same manner. There are two water tanks with duplicate street connections and two Worthington compound duplex pumps, which can be connected either to street service or tanks. These pumps have 10 and 16-in. steam cylinders, 8½″ plunger and 10″ stroke, and are capable of delivering from 365 to 610 gallons per minute. The economizer and heater have bi-passes, so that the feed water circuit is independent of their operation. Each boiler is also equipped with a "Korting No. 14" injector.

The four Sturtevant fans are each operated by a 25-hp Westinghouse engine and there are two conveyor engines and one stoker engine of the same size.

The engine and dynamo room, which fronts on Market street, is 147′ 4½″ long, 80 ft. wide and 50 ft. high. It contains at present three 600-hp Westinghouse compound engines directly connected to four pole generators of the "Kodak" type and one 1,500-hp Wetherill Corliss engine and Westinghouse generator, duplicates of those at the 13th and Mt. Vernon station already described.

During the next year another of these 1,500-hp machines will be installed.

The valves are all within reach of the platform around the engines and those from top of boilers have the original valve wheel in addition to extension spindles, and additional wheels so as to shut off steam in the boiler room in case of serious accident. They can also be shut off from the engine room platform.

The station is also equipped with one 10 ton and one 20 ton Sellers' crane, with electric propulsion but hand hoist. The switchboard is practically the same as in the other stations, as well as the testing room, vaults, etc., which have already been described.

32d and Dauphin Sts.—Station D.

This station, which is now being constructed, is to feed the circuits in the northern section of the city. Fig. 10 shows the exterior of this station, which differs from the others in being built of light yellow brick instead of red. The building at the corner is the engine and dynamo house, the next the boiler house and the last the new car shed, capable of holding about 200 cars. Fig. 11 is a plan and elevation of this power station showing the location of the machinery, the distinctive feature here being the use of vertical boilers, the other stations all having horizontal boilers.

The boiler house, which is 142 ft. long, 49.5 ft. wide and 35 ft. high, is to be equipped with eight 250-hp Berry fire tube vertical boilers with natural draft. The brick stack is 8 ft. diameter and 128 ft. high.

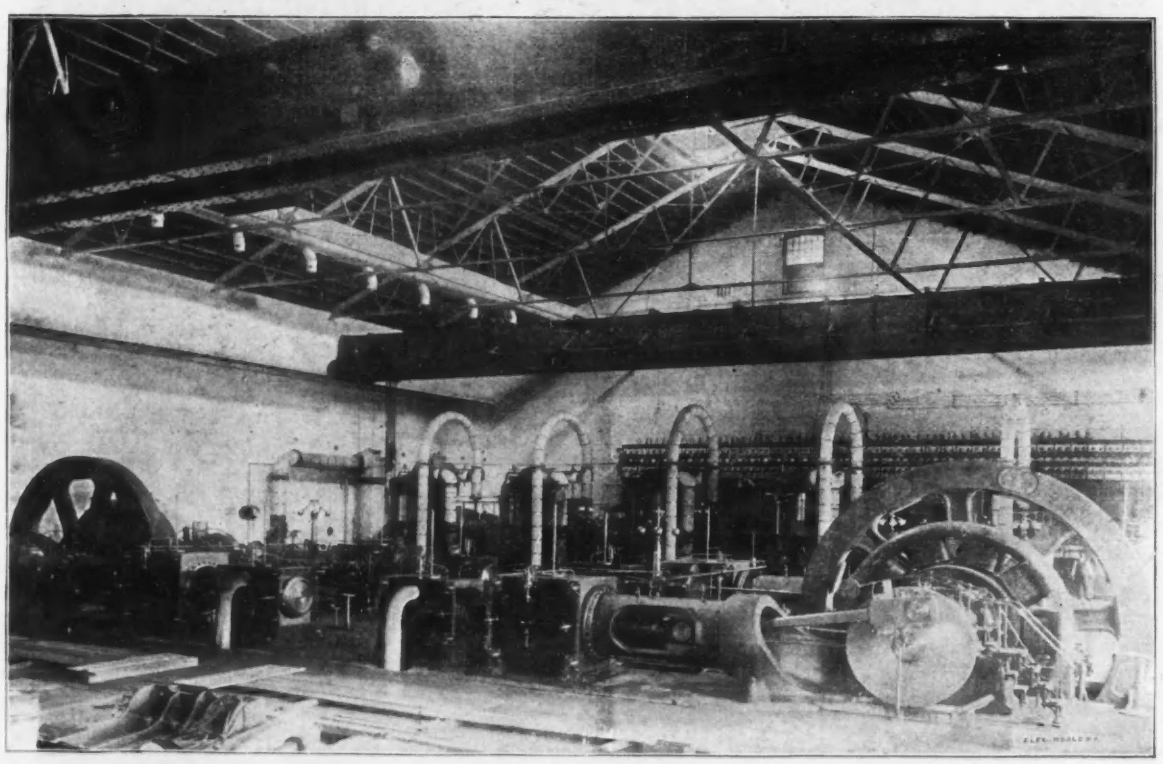


Fig. 6.—Completed Portion of Engine Room, Mt. Vernon Station.

(To be continued.)

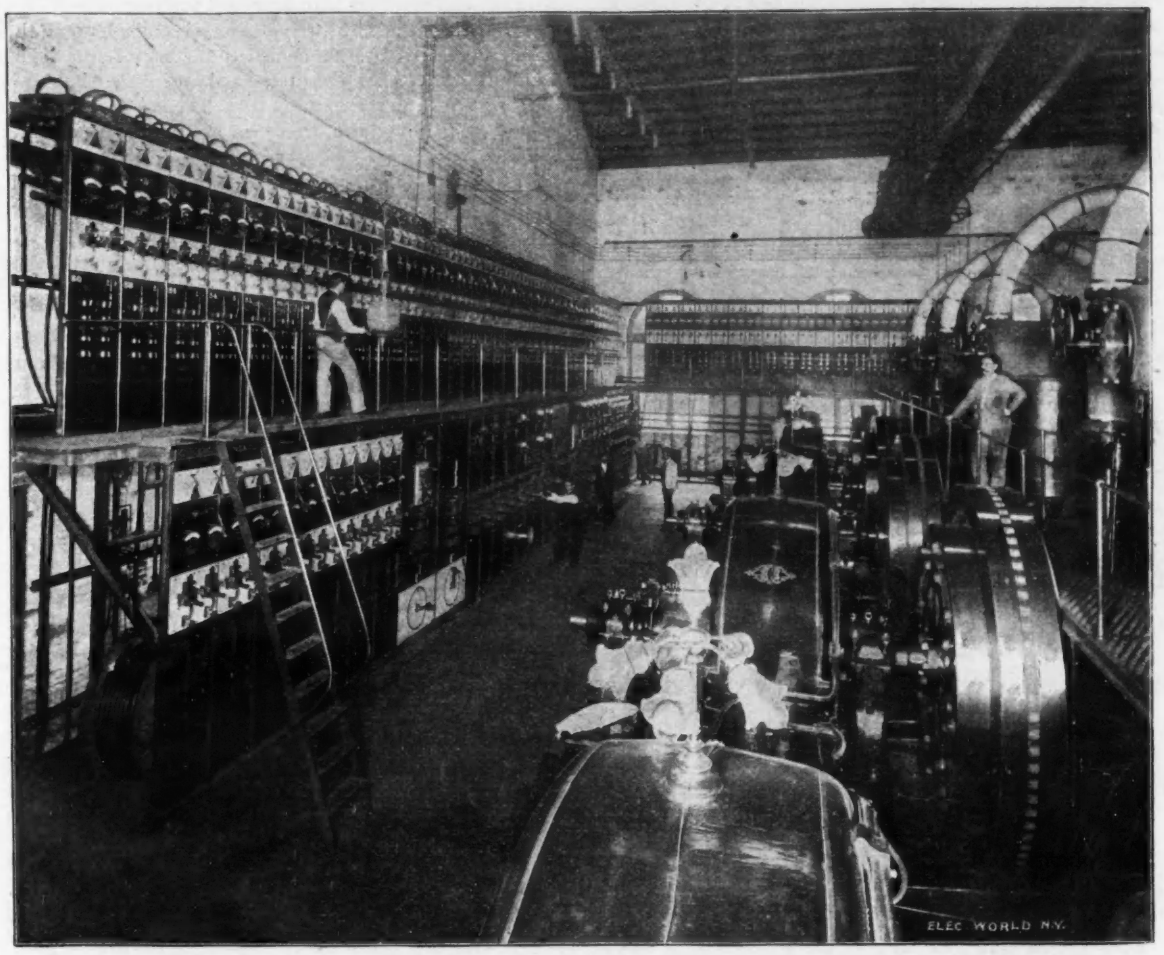


FIG. 7.—SWITCHBOARD OF MT. VERNON STATION.

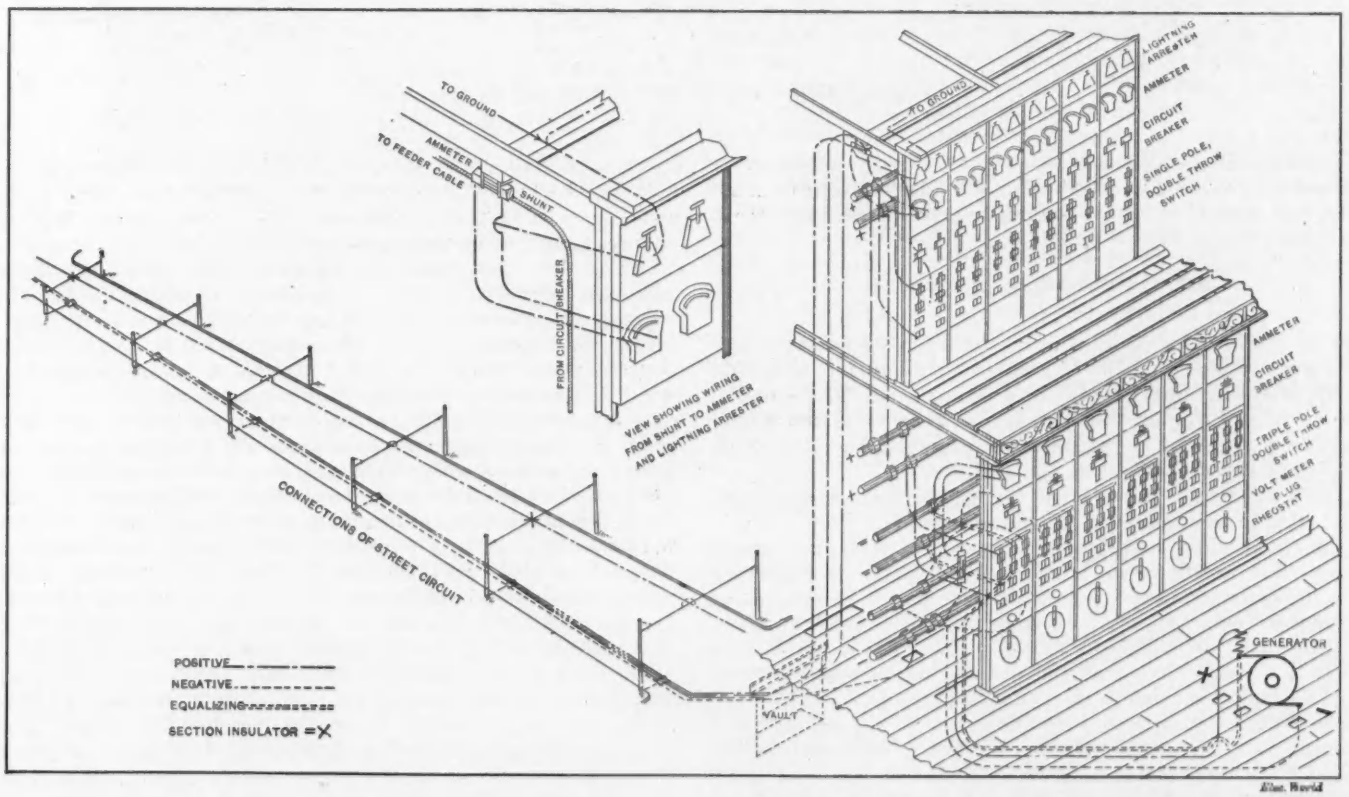


FIG. 8.—SWITCH BOARD CONNECTIONS.

The engine house, which is 142 ft. long, 49.5 ft. wide and 35 ft. high is to be equipped with three 750-hp Wetherill-Corliss cross compound twin engines directly coupled to Westinghouse generators similar to those already described.

The switchboards, vaults, etc., will be similar to those of the other stations.

All of the buildings and stacks built for the electric system of this company were the work of Samuel Hart & Son, of Philadelphia, and reflect great credit upon these builders, as the construction work seems to be thoroughly substantial, well adapted to the desired purposes, and withal in very good taste without any extravagant ornamentation.

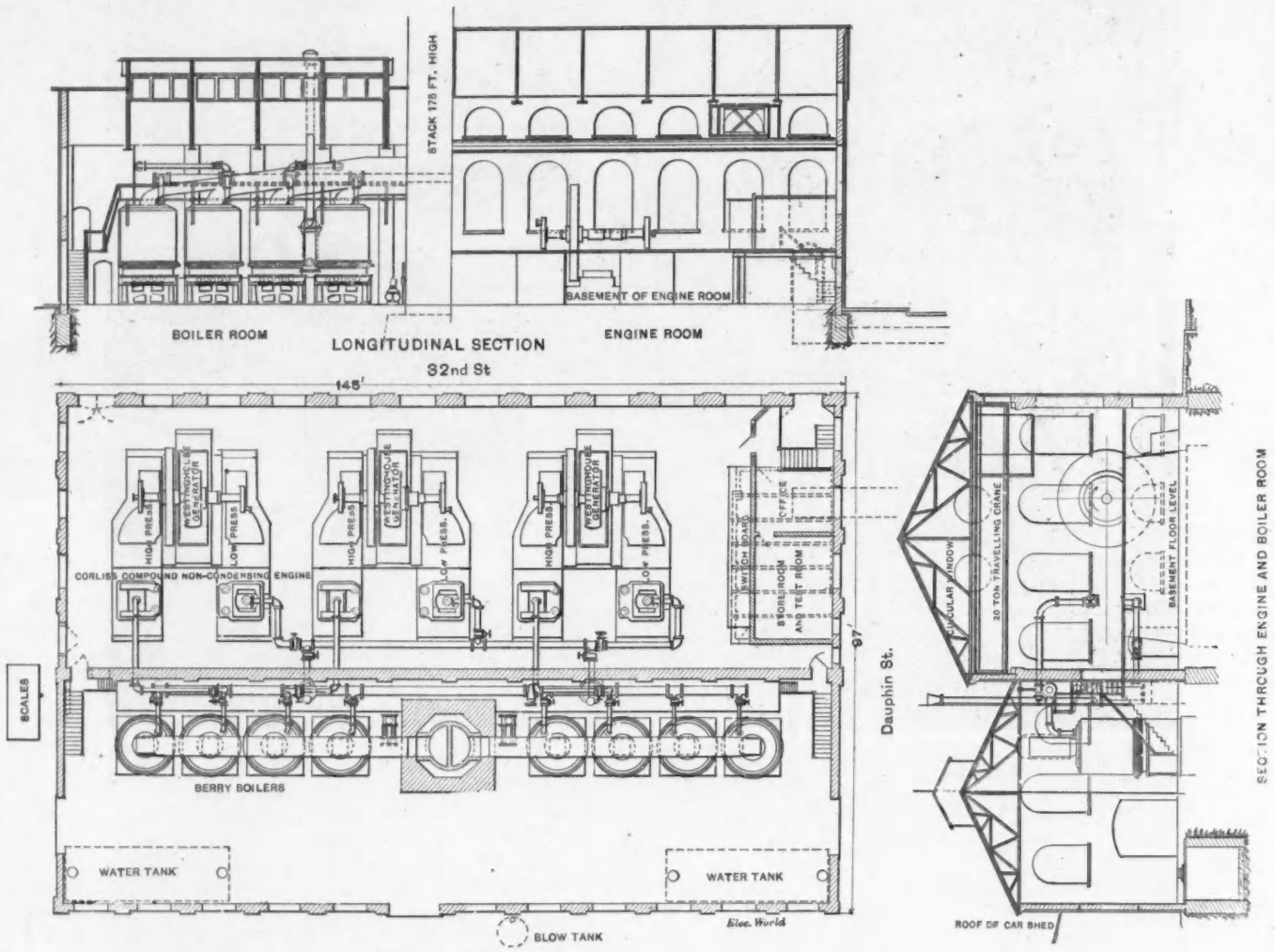


FIG. 11.—DAUPHIN STREET POWER STATION.

Storage Battery Litigation.

Judge Lacombe, of the U. S. Circuit Court for the Southern District of New York, on October 10 granted a preliminary injunction on the application of the Accumulator Company of Philadelphia, against the Edison Illuminating Company of New York, restraining the latter from installing storage batteries manufactured by the Electric Storage Battery Company of Philadelphia.

The court said that in considering the application for a preliminary injunction in the present case, the construction laid down in Judge Coxe's opinion sustaining the patent of the Accumulator Company, whose infringement is alleged, will be adhered to. The claim of the patent in that suit was for secondary batteries having perforations or cells extending through the plates, and the active material, or material to become active, packed in the perforations or cells only. Judge Coxe held that the combination, in which the perforations extended through the plate and the material filled the perforations only, was original with Swan; that it was not only new but a useful and important advance in the art, and that the idea which has made these plates a commercial success was first given to the world in a practical embodiment by Mr. Swan. Judge Lacombe adds that no new evidence tending to modify this opinion has been introduced, so that the only question to be decided is whether the defendants' plates infringe.

As the plates alleged to infringe are perforated, the perforations extending through with active material embedded in them, he holds that infringement by the completed structure is so plain that the defendants have been constrained to insist that Swan's patent is practically for a process, and, therefore, as defendants' process is a different one they claim there is no infringement; they also insist that the material which they use is not active when the process of packing antimonious lead around it is complete, and that it does not become active the moment it is placed in the battery fluid, but requires further electrolytic treatment.

In regard to these claims the court states that manifestly the result is the same whether the material is packed within the bounding walls of the perforations or whether the bounding walls are packed around the material; and the complainant's patent is not confined to active material, but includes "material to become active," and whether it becomes active through one process or another is practically immaterial. The gist of Swan's invention, as defined by Judge Coxe, was the confining of the material which was to do the work, within perforations which extended completely through the plate.

While defendants did manufacture and sell cells for some years their plates were not the same as the plates now complained of. Both were equally infringements of the patent, but the complainants state that they did not prosecute the infringement by the early plates for the reason that they did not believe them to be commercially harmful. The grounds for that complaint are said to be the relative size of plate and button. In the latter plates the loss by accident while in use of the contents of a single cell, would not, it is asserted, practically destroy the usefulness of the plate, being only a loss of 1-256ths of the active material. A similar accident, however, to the older plate would destroy its usefulness, as a single perforation holds one-ninth to one-twelfth of the active material. This explanation seemed to the court a reasonable excuse for failing to prosecute them against the older plates.

The Street Railways of Atlanta.

Atlanta has a greater mileage of street railways in proportion to population than any other city in the United States. With the exception of .8 of a mile of track over which a mule car is daily hauled to hold a franchise, this mileage is operated entirely with electric cars. The visitor to the Street Railway Convention will find, in all, three street railway companies, each operating separate lines, aggregating, in equivalent length of single track, 96 miles of line. On these lines almost every type of electric railway motor is in use, from the old Sprague No. 6 to the latest types of the single reduction motor, thus affording a good opportunity to the inquiring visitor to compare the relative advantages and the practical workings of the different makes.

There is no doubt but that the street railways of Atlanta are at present somewhat in advance of Atlanta's needs, but that the city will soon grow to need them all and some more in addition, those who know anything of Atlanta's growth and spirit, most confidently assert. In 1880 the population was 37,000; in 1890 it was 65,533 and at present it is over 100,000 and estimated at 110,000. With such a rapid growth as this the street railways of Atlanta will certainly not lack for patronage in the future.

The largest street railway company in Atlanta, and the one operating on the principal streets of the city is the Atlanta Consolidated Street Railroad Company. This company was formed, as its name indicates, by the consolidation of all the old street car lines of the city, and was chartered May 16th, 1891. It is the consolidation of the Atlanta Street Railroad Company, the Gate City Street Railroad Company, the West End and Atlanta Street Railroad Company, the Fulton County Street Railroad Company, the Atlanta and Edgewood Street Railroad Company and the Metropolitan Street Railroad Company. All of these companies, except the last two, operated their lines with mules and all were electrically equipped by the Consolidated Company. The Atlanta and Edgewood Street Railroad line was the first one equipped with electric cars (in 1889, 1890), and was operated with the old double reduction Thomson-Houston motors. The Metropolitan Street Railroad Company operated a steam dummy line from Atlanta to Decatur, and the motive power has only recently been replaced by electricity, thus completing the electrical equipment of the entire system. The Atlanta Consolidated operates 52¾ miles of main line, with 11 miles of second track and sidings, forming a total length of 63¾ miles, 33 of which run through paved streets. The greater portion of the line is laid with 40-pound T rail, some 44 miles, the balance of 19½ miles consisting of 40-pound to 56-pound girder, four miles Providence girder and 15 miles of Johnston girder rails. The rails are supported on pine and oak ties laid in sand, an intermediate stringer being used for the T rail where it is used on the paved streets.

The overhead construction consists of a number O copper trolley wire, supported by hangers of the General Electric type; throughout a radius of one-quarter of a mile from the center of the city 27 feet Walworth iron poles are used, wooden poles being used on the remaining portion of the system. Bracket construction is used only on lines outside of the city, all the city lines having a span supported trolley. For the ground return a number O, supplementary copper wire is connected to rails on both sides of each joint. On the lines constructed within the past year and a half, the rails have simply been bonded with No. O copper bonds.

The motor equipment consists of 108 General Electric S. R. G., 15-hp motors (54 double motor equipments), 4 latest type Westinghouse double motor equipments and 2 G. E.-800 double equipments, only single reduction motors are used, as the first equipment of 6 F-20 T-H motors have been discarded.

These motors are fitted to Bemis trucks and are used beneath 47 box cars for winter, and 40 open cars for summer travel. The open cars are 26 ft. in length over all; 20 are Pullman, 8 Brill, 2 Jones, 4 Lewis & Fowler, 2 of Consolidated Company's own manufacture, and 4 made over from old passenger cars used on the steam dummy line. The closed cars have 16 ft. inside length and are mostly all Lewis & Fowler and Stephenson, with a few Brill.

Power is supplied the road from the company's own power station situated in the northeast section of city, and the station of the Georgia Electric Light Company in the western part of the cit

The company's power station is built of brick with wooden trusses supporting a tar and gravel roof. The dimensions of the building are 50x100.

In the boiler room are three return tubular Bigelow boilers, each 6 feet in diameter and 16 feet long with a nominal capacity of 150-hp each. To these there has lately been added one vertical Manning boiler of 250-hp capacity.

The engine and dynamo room originally contained two 250-hp Cooper-Corliss Engines with cylinders 20x42, which were belted to a line of counter shafting, to which in turn were belted seven 85-hp T-H generators of D-62 type. About a year ago the company decided, in the interests of greater economy, to replace these small sized generators with large units, and so made a contract with the Westinghouse Company for two 300-kw, and one 500-kw railway generators. The countershafting and the D-62 generators were taken out and the two 300-kw dynamos were put in position and directly belted to the two Cooper-Corliss Engines. In the centre of the engine-room a Rankin-Fritch compound condensing engine has been installed, directly coupled to the 500 kw generator. This engine makes 90 revolutions per minute, has cylinders 22″ and 40″ in diameter with 48″ stroke, exhausting into an independently operated Smith-Vaile duplex condenser, having steam cylinders 12″, and water cylinders 16″, in diameter with 24″ stroke. Water is supplied from a tank 8½ ft. deep by 55 ft. in diameter, and is kept cool for condensing work by pouring it over a twenty-foot fall inside of a large wooden box. In the sides of this box are four 6-ft. radial fans driven by two R. G. motors which force a current of cooling air upon the cascade of water returning from the condenser. The station is situated along side of the main line of the Railway Company, and receives its coal cars on a trestled side track where the coal is dropped through upon a chute and delivered to the door of the boiler room.

Adjoining the station are the car barns, two large frame buildings, 80x120 feet each fitted with pits, transfer tracks, etc., for the proper storing, handling and cleaning of the cars. In one of these barns is a complete carpenter shop, where the company manufactures its own car bodies. Between the barns and station is the machine shop 25x50 feet and foundry 30x30 feet.

The foundry has a brass furnace and a small cupola iron furnace permitting the company to cast its own journal brasses, trolley wheels, brake shoes, axle gears, gear cases, car fittings, etc.

The machine shop is operated by a 15-hp Thomson-Houston stationary motor, and contains lathes, a drill press and other machinery for the finishing and fitting up of repair parts and castings.

Power for the lines in the eastern part of the city is furnished from the station of the Georgia Electric Light Company. This station is 129x153 ft., and is built of brick with iron roof trusses.

The Atlanta Consolidated has installed here five 90-kw General Eletctric multipolar generators. The Georgia Electric Light Company operate them and furnish power by the meter at a charge of 2.7 cents per kilowatt hour. The engines that are specially used for driving the railway generators are two tandem compound condensing McIntosh & Seymour high speed engines with cylinders 14½″x23″ with 22″ stroke; each engine has a rated capacity of 500-hp. These engines are belted to a line of counter-shafting which transmits by pulleys and Eclipse clutches to any desired generator. The capital stock (common stock) of the Consolidated Company, authorized and issued is $2,000,000, the par value per share being $100.00. Of the $2,250,000 of first mortgage gold bonds authorized, there are issued and outstanding $1,953,000 and $225,000 reserve, held to retire outstanding gold bonds of the Atlanta Street Railroad Company. In addition $72,000 are in the hands of trustees for cost of additions to property. These bonds are coupon bonds, due 1921 and of $1,000 denomination. The original interest was 6 per cent., but this was scaled down by agreement in November, 1893, to 3 per cent. for two years ending July 1st, 1895, and to 5 per cent thereafter for the life of the bond. The stockholders in Nov., 1893, were assessed to pay the floating debt and received $212,000 in income gold bonds which bear interest at 8 per cent. and fall due in 1924. The following is a statement of the operating expenses and earnings for the years 1893 and 1894:

OPERATION, YEAR ENDING APRIL 30, 1894.

	1893.	1894.
Gross receipts from passengers	$351,568	$299,311
" " " other sources	510	329
" " total	$352,078	$299,640
Operating expenses	249,528	205,119
Earnings	$102,820	$94,521

DEDUCTIONS FROM EARNINGS.

Interest charges	$97,524		
Taxes	14,066		
Miscellaneous	7,974		
Deficiency	25,043		
Per cent. of operating expenses to totals receipts		70.7	68.3

The average car mileage per day is 4,500, giving a passenger income per car mile for 1893 of 21 4-10 cents and for 1894, 18 2-10 cents. The operating expenses per car mile for 1893 were 15 9-10

cents and for 1894, 12½ cents. Annual increase per mile of street for 1893 was $6,633.17 and for 1894, $5,647.40.

The following is the last balance sheet:

BALANCE SHEET APRIL 30, 1894.

Assets.		Liabilities.	
Road and Equipment	*$4,392,925	Capital stock	$2,000,000
Cash assets	22,624	Bond account	2,153,000
Material	4,658	Income bonds	212,000
Bills Receivable	758	Accrued Interest	29,363
Miscellaneous	798	Accounts payable	20,094
		Reserve	7,306
	$4,421,763		$4,421,763

*Including profit and loss, $121,127.

The officers of the company are as follows: President, Joel Hurt; Vice-President, E. Woodruff; Secretary, T. K. Glenn; Treasurer, R. J. Lowry; General Superintendent, H. N. Hurt; Purchasing Agent, W. H. Glenn; Electrician, N. W. L. Brown.

This road is one of the finest pieces of street railway property in the South. While there are portions of the road at present unprofitable, such lines will in a short time prove remunerative. The road has been put through a rigid system of economy for the past year. Conductors have been dispensed with on many lines, thus effecting a marked saving. Everything points to a successful future for this company.

The Atlanta Traction Company sprang from the consolidation of three roads. The first part of the road built was known as the Atlanta, West End & McPherson Barracks Railway, running from Atlanta to the United States barracks. This was built in 1890, and in 1891 a connecting line was constructed to Grant Park by the Grant Park Electic Railway Company, which was composed of practically the same men as the original company. These lines were in 1892 consolidated under the name of the Atlanta Traction Company. In 1892-1893 the Atlanta City Street Railway Company constructed a line running from Atlanta to Decatur & East Lake. In March, 1894, this was consolidated with the lines of the Atlanta Traction Company, a mile of connecting road was constructed, and the whole came under the name and management of the Atlanta Traction Company. In May, 1894, the road was placed in a receiver's hands.

The combined lines form 22 miles of single track road, no double track being used except in crossing a bridge in the centre of the city. The road is laid with 40 pound rails on sawed ties, the rails being bonded and cross connected with number 0 copper wire. The overhead line consists of No. 0 trolley wire with both cross suspension and bracket construction.

The rolling stock consists of 26 cars, 13 closed and 13 open. Of these 17 are Brill, 66 American, 3 Rogers, and 2 second-hand Rogers from the West End Railway Company, of Boston. There are four double bogie truck, Brill, extra long open cars, two of them equipped as double-deckers. The trucks are of Brill, Rogers, Graham and McGuire construction.

The motor equipment is quite diversified for one road, and consists of five double equipments of the old Edison No. 6 double reduction motors, eight double equipments of Westinghouse single reduction motors, four of latest type, two double equipments of Edison No. 16 single-reduction motors, and six Detroit 30-hp double reduction motors. There are also on hand two Detroit single-reduction 50-hp. motors, which are not used.

Each of the two separate companies contsructed its own power house, and the great length of road running from east to west through Atlanta makes the use of two power stations very necessary. These stations are situated in the eastern and southwestern parts of the city. The power stations of the original barracks line is a brick building 70x50 on the line of the E. T V. & G. R. R. running south of Atlanta.

A 12-hp Russell return tubular boiler and two 125-hp McLaughlin upright tubular boilers furnished steam for two Russell engines. One engine with cylinders 14x20 inches, and of 125hp capacity, is directly belted to an Edison two-pole 80-kw dynamo, and the other engine of 250-hp capacity, cylinder 20x27 inches, drives two Eddy 110-kw multipolar dynamos. Adjoining the power house is a frame car barn 100x80, and the machine and repair shops of the road.

For the eastern section of the road power is furnished from a brick station 30x50 feet, situated along the main line of the Atlanta Charlotte Railway (Southern Railway Company). Power is furnished here from two 100-kw Detroit dynamos, driven with direct belting by two 125-hp Russell engines, having cylinders 14x20 inches. Steam is furnished from a battery of two 125-hp Chattanooga return tubular boilers. Adjoining this station is another frame car barn for storing cars on eastern end of the line.

In the operation of the road cars run on regular twenty minute schedules, keeping five cars in regular operation. Motormen and conductors receive 12 cents per hour, an average day's work being 12 hours; engineers, $60 per month, and the superintendent $75 per month. The following is a statement of earnings and expenses for the month of August, 1894. The expenses are very heavy from the fact that the road and equipment were in bad condition when placed in the receiver's hands, and have had to be fully repaired. Much of what is charged up to expenses is properly betterment and improvement.

EXPENSES.

	July, 1894.	August, 1894.
General Expenses—		
Salaries of officers and clerks, insurance, etc	$547.78	$1,349.99
Transportation Expenses—		
Car Service	1,771.38	1,727.74
Car-house and power-house, oil, etc	924.42	697.85
Fuel	818.72	571.65
Maintenance of Way and Buildings—		
Repairs, roadway and track	222.21	247.12
" buildings and structures	19.92	2.15
" and renewals, overhead line	112.16	111.25
Maintenance of Electric Equipment—		
Repairs of cars	212.49	281.65
" electric equipment of cars	616.31	573.04
" steam plant	4.78	23.06
" electric power plant	10.90	.60
" tools and machinery		4.05
Miscellaneous expenses	98.25	41.00
Total	$5,339.32	$5,631.15

RECEIPTS.

Gross receipts from passengers	$5,988.35	$6,186.80
" " other sources	10.00	92.50
Total	$5,998.35	$6,279.30
Per cent. operating expenses to total receipts	89. p.c.	89.6 p.c.

The floating debt is about $25,000. Car mileage, 2,500 car miles per day.

	July, 1894.	August, 1894.
Passenger Insurance per car mile	$6\frac{8}{100}$c.	7c.
Operating expenses " "	$6\frac{7}{10}$c.	$6\frac{42}{100}$c.

The authorized first mortgage gold bonds of the original Atlanta Traction Company amount to $300,000, of which $162,000 are issued. The Atlanta City Street Railway Company had $200,000 of bonds and $200,000 of capital stock. When the latter road was bought in by the Atlanta Traction Company, the $200,000 of bonds was assumed by the Traction Company and the $200,000 capital stock cancelled. Since the consolidation of the roads $75,000 of second mortgage gold bonds have been issued. The first mortgage bonds are coupon bonds dated 1891, due 1916, of $1,000 denomination, and bear interest at 6 per cent. payable in May and November of each year.

The receivers of the road are Judge E. B. Rosser, president of Exchange Bank, and Mr. William C. Hale, president of State Savings Bank, both of Atlanta. Mr. G. W. Evans is superintendent of the road.

The Collins Park & Belt Railway is an example of a road built entirely uncredited and without a cent of bonds or capital stock. Projected in 1891, and finished in 1892, this road extends 15 miles westerly from the centre of the city to the Chattahooche River and was known originally as the Atlanta & Chattahooche River Railway. In June 1892, when the road was started up, the Electrical equipment not being ready, a dummy and some cars were rented and put into operation. While so operated a very bad accident occurred, due to spreading of rails, in which several people were killed and a number badly injured. This caused considerable litigation, and the name of the road was changed from the Atlanta & Chattahooche River Railway to the Collins Park & Belt Railway. The lack of patronage, the financial crisis and the pressure of creditors precipitated a change soon after the road was equipped, and a receiver was appointed in the person of Mr. G. F. Darr, in March, 1893.

At present nine miles of the road are in operation. The line is constructed with 56 pound T-rails laid on sawed pine ties, and banded with No. 0 galvanized iron bonds, as well as connected to No. 0 supplementary iron wire. The overhead line is of span construction inside of the city, and bracket supported beyond the city limits. The trolley wire is No. 0 copper, supported by overhead hangers and devices of the Short Company, fed by No. 0000 copper wire. Nine Brill cars constitute the rolling stock, seven 8-seat open cars, and two 16-feet closed cars. These are equipped with Dorn & Dutten trucks and 33-inch wheels.

The motors were first of the single reduction type produced by the Short Company, known as the split diagonal, and are of 20-hp capacity. There are nine double equipments of these motors.

The power station is 100x60, built of stone and situated about five miles from town. The station equipment consists of three 200-hp return tubular Janes boilers, fed by two Worthington

feed pumps with 8-inch steam and 6-inch water cylinders. These boilers furnish steam to two 18x44-inch Allis-Corliss enignes, having 18 feet fly wheels and running at 90 revolutions per minute. These engines are connected by 24 feet belts to two Short 300 ampere railway generators, running at 500 revolutions per minute.

Coal is hauled to the power stations in regular freight cars by the motor cars. The cars run on a regular thirty-minute schedule from 6 a. m. to 8 p. m., making the round trip of 18 miles in two hours. The heaviest grade on line is 7 per cent., which, with a curve, is equivalent to a 10 per cent. grade. The line runs through a sparsely settled section and can only prove a paying line with the building up of the surrounding country.

The estimated cost of road is $250,000. Among other liabilities are the following: Short Electric Railway Company, $50,000; Brill Car Company, $5,000; Venable Bros., of Atlanta, preparing material, $5,000; E. H. Jones, of Cleveland, Ohio,, for steam plant $35,000; C. J. Simmons, of Atlanta, for road construction and power house, $60,000. The gross income per year is $16,000, all from passenger receipts, and the net annual earnings are $3,000. This makes $13,000 for annual operating expenses, giving percentage figure of operating expenses to gross income of 81 per cent. The car mileage is 576 car miles per day, and the gross income per car mile is $7.61. Operating expenses per car mile are $6.18.

The annual passenger income per mile of road is $1,777.

Notes on the Management of Railway Power Stations—III.

BY GEORGE T. HANCHETT.

THE ENGINE.

There is no more trusty servant in the power station than the engine, if it is intelligently managed and well cared for, but it will not bear abuse and neglect.

A new engine, like a recently tightened bearing, requires careful watching on the first days of its running. The bearings should be felt of frequently to be sure that they do not heat. The cylinder and valve chest should be brushed over with cylinder oil and then carefully inspected to see if any bubbles appear on the surface. This will detect "sand holes," and if there be any they should be at once plugged as they will quickly cut larger. Bore them out

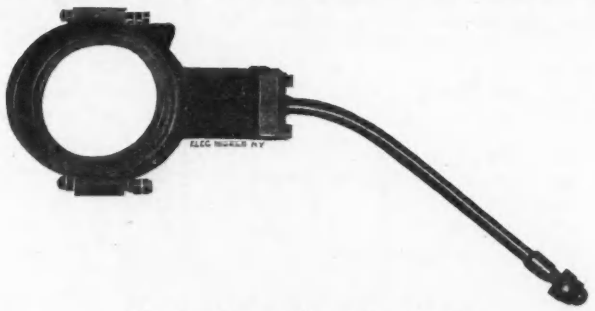


FIG. 8.—BENT ECCENTRIC ROD.

with a small drill, allowing it to enter the plate about one quarter inch. Then tap out the hole with a "bottoming" tap and cutting a tapering thread on a suitably sized wrought iron rod, screw it into the hole till it wedges, and cut off squarely and polish. A hot box is very liable to occur on a new or recently keyed bearing. The following remedies should be tried in the order given, and each should be tried thoroughly before the next one is attempted.

First—Start the oil cups to running profusely.

Second—If the bearing will admit of it loosen the cap screws.

Third—Flood the bearing with cylinder oil or soft soap.

Fourth—Try ice or a steady stream of cold water.

If all remedies have been persistently tried without avail, shut down. If the case has gone so far as to need remedy then the box should be rescraped before the engine is run again.

Ice and water should be used with the greatest caution on a dynamo bearing, if at all. The armature may be ruined by carelessness in this regard. A hot-box should seldom, if ever, cause a shut down. In a lighting plant it is often better to ruin a wrist pin or crank pin rather than shut down, but in a railway power station this is not so necessary.

The cylinder lubricator should always be in the best of order. Failure of the lubricator to work may result in a valve sticking and a bent ecentric rod is the result, Fig. 8. Often this accident is caused by the eccentric strap itself becoming hot and sticking.

In dismounting an engine or other heavy machines the writer has found the simple apparatus shown in Fig. 9. very useful. The figure is self explanatory. A small bar of steel, a short piece of nine or ten-inch pipe, a wooden beam of sufficient strength, a few pieces of rope and a little common sense will produce a temporary crane on this principle that will be very efficient.

To throw a large engine off a dead centre, when there are no means of barring the wheel, is often more or less trouble. Often the engineer does not realize that he has the very agent at command to do this work. Connect the generator to the bus bars of the switch-board interposing one of the switch-board rheostats, being

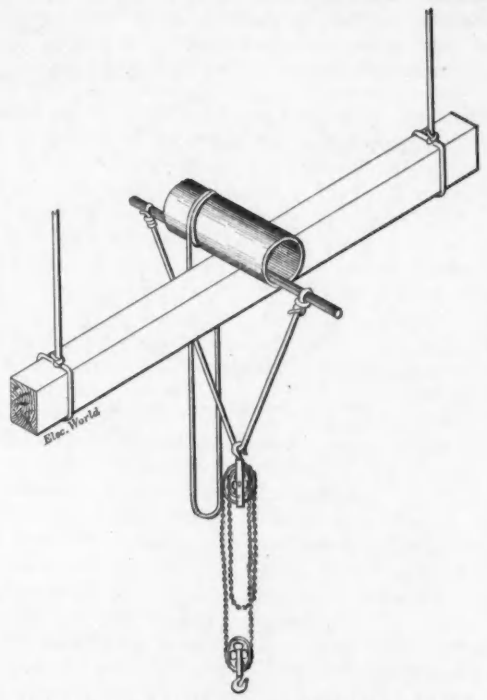


FIG. 9.—APPARATUS FOR DISMOUNTING.

careful to choose a rheostat of sufficient capacity for the purpose. Allow just enough current to enter the generator to overcome the friction of repose and the large engine may easily be turned over by hand.

The writer has by this means turned over a 90-hp plant, in which there were a large number of machines, and long jack shafts making the friction of repose very great. It usually required two men to turn over this plant and the ease with which the writer turned over the plant with one hand excited the wonder of an on-looker, who subsequently tried it himself when the current was off and found that it stuck.

The centrifugal governors of high speed engines often act

FIG. 10.—DETERMINING ACTION OF ENGINE VALVE.

sluggishly and sometimes stick fast. This will cause a runaway when a portion of the load is thrown off and the consequent rise in voltage is liable to ruin lamps, if they are in circuit. In the case of a power station the rise in speed does not become such a serious matter till it becomes so high as to endanger the fly wheel by excessive centrifugal force. In any event such a governor is to be corrected at the earliest possible opportunity. It should be taken apart, thoroughly cleaned of all old oil and carefully inspected for burrs roughnesses, etc. If these exist they should be removed with a fine file and repolished with fine emery and crocus cloth.

The writer knows of a case where the engineer keeps a fruit can

of oil handy, and whenever his engine races, due to the sticking of the governor, he deluges it with oil in such a dextrous manner as to excite one's sense of the ridiculous.

The writer would recommend this expedient in case of an emergency, but the constant use of such methods is too slovenly to be tolerated.

Much may be learned from the sound of an engine as it runs. Take a pencil between the teeth and close both ears and rest the pencil against the head of the cylinder. With a little practice the hissing sound of the admission and expansion gradually dying away as the exhaust begins and followed by the dull thud of the compression may be readily distinguished. If the valves are of the Corliss type or similar open valve gear a piece of pack thread can usually be attached to the valve and so arranged as to twitch

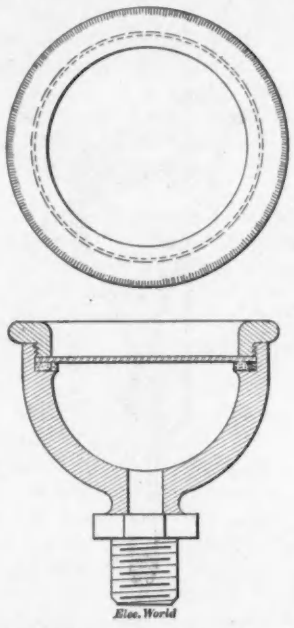


Fig. 11.—Water Relief Draphragm.

the elbow at the point of cut off This will assist very materially in distinguishing the various events of the stroke. By listening to engines that are set correctly a person can gain very accurate ideas as to how an engine should sound. This method will prove useful principally in estimating whether the compression is excessive. See Fig. 10.

The sound of water in the cylinder needs no stopped ears and lead pencils to detect it. Every station engineer has heard that metallic chink and instinctively opens his cylinder cocks and stands by the throttle. Many a cylinder head could have been saved by the use of a relief valve. If these are not provided with the engine a good expedient is to screw a diaphragm, such as is shown in Fig. 11, into the holes tapped for the indicator cocks. These will burst and relieve the pressure. They are made by several firms and can be fitted to any engine.

To be economical an engine should be supplied with good dry steam, and steam superheated a few degrees is a great advantage.

Hirn's analysis has shown beyond all question the losses of wet steam. The steam enters the cylinder; being hotter than the cylinder it loses some heat to the walls. Then cut off takes place and the steam expands, falling in temperature as it does so. If the steam is saturated when it enters, the losing of heat to the walls precipitates a thin film of moisture thereon. This film is re-evaporated during exhaust by the walls as they are hotter than the steam after it has expanded, and the steam thus formed leaves the engine without having done any work.

If the steam be superheated when it enters, the heat lost to the walls during admission is the heat of the superheat and no film of moisture is precipitated. This heat will be more or less retained by the walls and will be an advantage during admission and expansion rather than uselessly re-evaporating a film of water to be thrown away with the exhaust. Nature has many ways of evading work and this method of dodging around the piston of a steam engine is, to say the least, most ingenious. If too strongly superheated the steam is liable to burn the cylinder oil and cause cutting of the cylinder, and trouble from this source is always serious. There are many forms of superheaters, but all of them are liable to burn out unless they have expert care. The best form of superheater is the common upright boiler, Fig. 12, which has its flue tubes passing through the steam space. Sufficient heat is absorbed from the hot gases by the water at A to prevent the burning of the exposed ends of the tubes at B. These exposed ends do the superheating and such a boiler, well used, will supply superheated steam.

Many station managers do not realize that by having one of the battery of boilers an upright boiler and passing all the steam of the battery through the steam room of that boiler, that a much more economical steam can be obtained.

The station manager should keep a note book devoted exclusively to the engines and dynamos. He should study the load from day to day and strive to so run his engines as to keep them fully loaded at all times during their runs. He should have in his book, among other things,

Time of starting and stopping.

Amount of oil used.

Hot boxes, if any.

Load as given by switch board ammeter and voltmeter.

Gauge pressure at various intervals during the run.

If there is an engine register, the number of revolutions of the run, and from the time compute the average speed.

Remarks comprising any events of interest.

Any cards that may have been taken.

It is not sufficient to take these data down. They must be carefully studied and each day's run must be compared with the rest, constant improvement being the aim.

Cards should be taken at least once in two weeks, and the writer does not hesitate to say that steam units of five hundred kilowatt or over should have the indicators on every day, and cards frequently taken. Every means should be employed to keep the engine running economically at all times. Under good conditions such a unit uses over a ton of coal per hour and too much care cannot be taken in the economy. A change of a small fraction of an inch in the lines of the indicator diagram may mean a loss of fifty cents to a dollar an hour. It therefore should be carefully watched. There are many forms of logs and performance sheets, but each station needs one peculiarly suited to its requirements. The station manager should see to it that some record is kept of the runs.

There is no reason why a railway power station should not be under as close supervision as the financial affairs of a business company. It is perfectly possible to determine exactly the cost of the power and the available power produced no matter how large the station; and there should be sufficient data on the manager's record

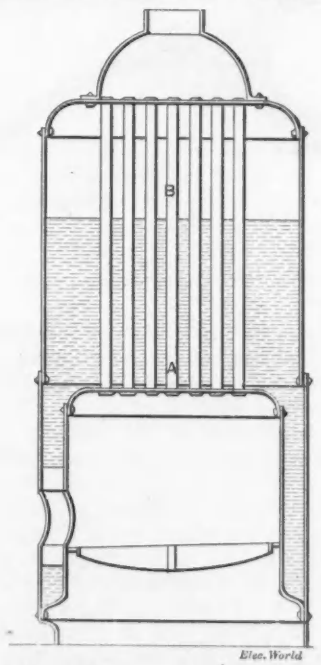


Fig. 12.—Superheating Boiler.

to obtain the cost of the power in cents per kilowatt hour.

Much power is wasted by the ignorant installation and use of small compound units. A compound high-speed, non-condensing unit is seldom economical, and a triple of this type never. Non-condensing compounds must be run at high pressures and be kept full of steam by running at full load, in order to be saving, otherwise the low pressure cylinders are simply air-pumps.

When the load of an engine is widely varying such units should never be employed.

(To be Continued.)

Street Railway Repairs.

BY J. B. CAHOON.

The question of repairs is one of the most important items in the annual expenses incident to the operation of street railways, and as all classes of roads have been in operation a sufficient time to enable them to form a fair estimate of this class of expense, provided they have taken care to separate this item in their accounting, it would seem that we can now take up this subject and treat it in an intelligent manner. From the reports received from various classes of roads, we find that in general four divisions are made as follows:

Line Repairs.
Track Repairs.
Car Repairs, and Motor Repairs.

In numerous instances we find only two divisions, classified as "Line and Track Repairs" and "Car Repairs." There should be, strictly speaking, a fifth class added, namely, station repairs; this latter, however, we find in many instances has been charged off to the general item, maintenance of motive power. It seems to us that too careful subdivision and classification of the operating expenses cannot be made if economy of operation is to be consulted, for if only general divisions are made, it becomes practically impossible to determine just where the heavy item of expense comes in, and what action is necessary to reduce these outlays to the lowest possible point. As an instance of the variation in the items of repairs, we find a large road, operating something over a hundred cars, reports cost of repairs per car mile as follows:

Repairs on Motor and Gearing	.00918
Repairs on Car Bodies and Trucks	.00442

The road bed in this case consisting of a sixty-six pound girder rail, granite paved street; length of tracks forty miles, steepest grade 5 per cent., though the general character of the road is level. Another road operating about twenty cars makes a division as follows:

Repairs on Engines and Boilers	.00110
Repairs on Dynamos	.00013
Miscellaneous Repairs on Power Plant	.00236
Repairs on Motors	.00166
Repairs on Gearing and Trolleys	.00552
Repairs on Car Bodies and Trucks	.00110

Making a total for repairs of Power Plant of .0036, and on rolling stock .0083.

Maintenance of road bed and track	.0067
Maintenance of line	.0015

To this may be added a separate item, which this particular road classified under transportation expenses, it being cleaning and inspecting cars, oil, waste, etc., at a cost of .00287, making a total cost of what may be properly classed under the head of repairs, of .02217 as the cost of this item per car mile. This is certainly very small. The road bed consisted of T-rail varying from twenty-five to fifty-six pounds, and girder rail varying from thirty-five to sixty-three pounds, the total length of track being six miles paved and ten miles unpaved; the steepest grade at any one point was 9 per cent. for a short distance, while the general character of the road was moderately heavy. This particular road was a comparatively new one, having been in operation about one and a half years when this report was made up, but we lay, in a large measure, the small cost of repairs to the excellent system of inspection which was faithfully carried out on the road. The cars were inspected carefully at the end of each day, two men going over every detail of the car, including motor and truck, brake mechanism, etc., and spent about twenty minutes to half an hour on each car wiping up excess of grease and giving the motors a brief cleaning, seeing that the bearings, brushes, etc., were in good condition for the following day's run and that no nuts were loose or cotter pins gone, and once a month the armatures were removed from the cars entirely and all parts of the motor thoroughly cleaned, the bearings overhauled, and replaced if much worn, armature and fields repainted and any little repairs made that were necessary to get the armature, fields and cables, etc. into first-class condition. The result has been that, although this road has been in operation now some two years and a half, their item of repairs has not materially increased, although they have found one or two points where a slight increase has been noticed; these points being in the track and line almost entirely; they finding that the light rails laid in the first place are not suited for the operation of electric cars and they are now relaying the tracks, as rapidly as the old rails give out, with sixty-three pound girder rails throughout. If we consider the showing made on these two roads on the two classes of repairs on which each gives data, it will be seen that the larger road, which ought to show, all things being considered, a less operating expense for repairs than the smaller one, shows just exactly the reverse. The repairs on the larger road being in the proportion of 136 to 83 for the smaller one; though in addition to its larger number of cars in operation and larger mileage, it had, to start with, a much better road bed than the smaller road. As it is well known that a good road bed is a material aid in lessening the cost of repairs on motors, car bodies and trucks, the reason for this poor showing is not far to seek and can be summed up in a few words—lack of inspection. Cars which are not overhauled until something gives out, as a natural result, instead of costing comparatively a small amount to repair, cause this item to often assume relatively large proportions. If managers and superintendents of roads would only stop to think on this subject a moment, they would readily see that if the apparatus needing repair is taken in hand upon first symptoms of trouble, the deterioration could be checked and the apparatus put into good repair at a very small expense, while, if allowed to run until necessity compelled them to take action, the deterioration would probably have gone so far as to cost a considerable sum to again place the apparatus in good condition. The only way in which it can be ascertained that the apparatus is in need of slight attention, is by a careful system of inspection regularly followed out; such a system was very fully presented in an article entitled "The Care of Motors for Electric Street Railways," published in the issue of the "Electrical World," dated August 5th, 1893; a summary of which is that for the car and its equipment there should be three kinds of inspection; one at the end of each trip, which is of the briefest kind, and in a general sense to see that the motors are in good running condition.

Second, The daily inspection, which is made after the car is run into the car barn at night; it being a more thorough inspection and general cleaning up of the motor and replacing of any minor missing parts and making minor repairs such as may be necessary to put the car in good condition for the following day's service.

Third, A monthly inspection of each car, in which the motors are taken apart, thoroughly overhauled, cleaned and repaired. It is, of course, to be understood that should any serious defect be found at any one of these inspections, the car will be put out of service and repairs made immediately. If, on the daily inspection, about half an hour be allowed to each car, it would be seen that in the course of a night an inspector could handle from fifteen to eighteen cars without very much difficulty, and on a pinch could look after twenty cars. With the inspector should be a laborer, who should go over the motors and clean them at the same time that the inspector is going over them. Such a system as this, if carried out, will do much to keep the cars in good running order and save very materially in the repair bill. In fact, the saving is much more than people are apt to suppose, and the wages paid this inspection and cleaning force is directly in the line of the best economy.

The aim of the large manufacturers of electrical apparatus of the present day is to make the apparatus so perfect that there will be very little danger of its getting out of order and so simple in its construction that should it get out of order repairs can be made by the street railway people themselves. I have heard quite a number of street railway men make the statement that such and such a company must make lots of money off of their repair work. This idea is erroneous; the large companies do not want the repair work, because they cannot do the work at a profit and it interferes seriously oftentimes with their regular work, which is the manufacture of apparatus. Therefore, I think I may safely say that the large companies would prefer each road to do their own repair work. Such being the case, the question arises as to whether it is cheaper for a road to return armatures, fields, commutators, etc., to the factories for repairs or do the work themselves. If a road is operating six or more cars, it would seem, from all the information I have been able to obtain on this subject, that it would be more economical for a road to do its own repairing, and in the case of large roads operating many cars, there can be no question but what a very material saving in both time and money can be made by their doing this. Assuming that a road has decided to do its own repairing, provision should be made so that this work can be carried on thoroughly and expeditiously; room should be set apart for this purpose, and none other, and should be properly fitted with the necessary tools required in the work, and particularly, there should be a lathe of suitable size for handling the armatures so that commutators may be turned down, bands put on, etc. For this purpose a good gap lathe seems to be about as useful as any and takes up less room and is not as expensive as is the more complicated machine lathe. Winding stands should be provided for the arma-

tures; these could be made up at very slight expense by making a very rough pattern of stand and providing it with two rollers in the top so that the shaft of the armature can rest on the rolls and thus be free to turn in either direction needed for winding purposes. Adjacent to the repair room should be the stock room, where should be kept a full supply of all materials necessary for making ordinary repairs, and it is always a good plan to keep a few commutators, brush holders and yokes on hand so that in case trouble occurs time will not be wasted in sending to the factory for these articles, and if armatures are wound with made up coils, a reasonable supply of these should be carried in stock at all times. These latter should be obtained from the manufacturers of the machine in question as they can undoubtedly furnish these better and cheaper than they can be made up by the roads themselves.

As many of the repairs to truck and motors will be made over the pit, attention should be paid to this latter particularly. I will venture to say that nine roads out of ten have a pit which is simply a long rectangular tank of the width of the track, and five to six feet in depth, with little or no attention paid to ventilation or heating, and but little more to lighting. If the managers and superintendents of roads would go down in those pits and lay on their backs and try to do work on a cold winter's day they would realize that a man would have to be a saint in order not to make the air blue with profanity for having to work in such a place. It certainly would cost very little more to carry the pit out on the floor for a couple of feet each side, deepen it to seven feet and place a narrow platform along the center about half the depth of the pit so that motors could be dropped down on this platform and overhauled there rather than dropping them into the old style pit and have to hoist them up on the floor above and handle them over half a dozen times. The time wasted in this latter method would, in the course of a month, pay for a decent pit. Provision should be made by means of steam pipes for heating the pit to a fair degree of warmth so that the men can work in comfort while there, and also ample provision should be made for thoroughly lighting the pit, not in the way most pits are, with about two incandescent lamps of questionable candle power attached to the end of a long piece of flexible cord which the men can take around with them to get light on the particular spot actually needed, but in the place of such an arrangement, light the pit up thoroughly so that the men can see to do work in all parts of it. Then in addition to this put in two 32-candle power lights with flexible cords and protected with wire screens for the men to handle around in bringing more light on to any one particular point. A little attention paid to small matters like these which enhance the comfort of the men, does more to make them contented and secures a better return for money spent in wages than almost anything else that has ever been tried.

There is one point that seems to be neglected by almost every street railway in connection with provision being made for repairs, and that is providing proper means for quickly mounting and dismounting the car bodies on the trucks. Motors are liable to be damaged while in service and a car run in at any time, needing more or less repairs, and it oftentimes happens that these are of such a nature as to necessitate the removal of the truck from the car body. A very simple means of effecting this removal is to provide a heavy wooden horse that can be placed under one end of the car body and provide a rope sling for the other end, in the upper end of which is placed the hook of a lower block of a heavy double purchase, the upper block of which is secured to a heavy cross beam overhead; then lead the running part of the falls through a snatch block on the floor and thence to the winch of a motor hoist, or, as illustrated in one of the papers some little time ago, make it pass to the cross bar of a car on the track and then by starting the motor or the car the car body is easily started clear of the truck, and when the truck is run out clear, another truck may be put in its place or the car body dropped on a second heavy wooden horse pending the return of its own truck.

REPAIRS OF STATION.

As previously mentioned, the repairs that occur in the power station should be kept distinct from repairs of cars, and as a rule roads do this, because the power station is distinct and separate from the car barn, but even in case the power station and car barn are in the same building, inasmuch as we are anxious to operate roads as economically as possible, and, therefore, to lessen the repair bills, the division should be made distinctly so that bad leaks can be discovered at once and proper remedies taken to prevent their further continuance. As far as possible roads should have a man for the chief engineer of their power station who has a good fair knowledge of dynamo electric machinery as well as a knowledge of steam engines, and he will then be able to act in an intelligent manner in case any trouble occurs and not go flying out the door of a station when he happens to see a ring of fire go around the commutator of the dynamo as I have known to happen on more than one occasion. The generator is, although often a ponderous affair, still a more or less delicate piece of mechanism, and should receive careful attention and a thorough cleaning and overhauling after a day's run, and every effort should be made to keep the generators clear from dirt and oil. After a machine is shut down it is always a good plan to take a good sized hand-bellows and blow the carbon dust out from the commutator leads and off the head of the armature. The modern armature for railway purposes is built of made up coils placed in slots in the armature and held in place by wooden wedges so that in case one or more coils should be burned out repairs can be made by the regular men in the station, provided they have some of the made up coils on hand as should be the case. For the large direct driven generators there can be no question but what the repairs must and should be made in the station, and under no consideration should the armatures be returned to the manufacturer. If an accident occurs to one of these armatures and it is felt that your armature winder is not competent to tackle the job of repairing it, then send to the manufacturer for a man to go to the station and do the work there as this will be materially cheaper than attempting to send one of these large armatures back to the factory, but it should be distinctly understood that the road requiring one or more of such large generators to operate it should have a competent armature winder among its force who could make any and all repairs to armature and fields of both generators and motors.

It is almost unnecessary to call attention to the necessity of keeping the engines in good condition so far as cleanliness is concerned, because it is a well known fact that a stationary engineer, if he is any good at all, takes pride in his engine and looks after it carefully, but as these are liable to get out of order in certain parts, it should be laid down as one of the most rigid rules, that indicator cards should be taken of each and every engine at least once a week, and should cards indicate a displacement of the valves, causing wrong working of the engine or loss of power, immediate steps should be taken to rectify this and not let the trouble continue until it becomes an actual necessity to make the changes or repairs.

The boilers being one of the most vital parts of the system, should receive the most careful attention and a thorough system of cleaning and inspecting should be adopted, for right here comes in one of the most important things in the economy of the whole system and that is the necessity of securing competent firemen. The importance of this cannot be urged too strongly on the attention of managers of street railways, for on this point may occur one of the most serious losses in the whole system; here, if anywhere, should pains be taken to secure the very best men that can be found in the market. It is the best of economy to pay a first-class fireman $2.50 per day or even more, but be sure that you get a first-class one. In the matter of pay of a fireman, I know of quite a number of instances where companies have paid first-class men $2 per day and a certain percentage on the value of coal they save over a certain amount which was deemed a fair average for running the boilers to produce the steam required. In every case this method has worked exceedingly well and has resulted in a material saving of coal in every instance, and I should strongly advise every road to follow out some such system as this, for it is easily seen if a man's pay depends not on how much coal he can throw in the furnace, but on how much he saves, he will look very sharply after his fires and will take an interest in the plant that he otherwise would not. The feed pumps, condenser and circulating pumps, together with the steam piping, should be carefully gone over at stated intervals by the chief engineer of the power house in person, and given a thorough examination to see that they are working in a proper manner, and in case leaks are discovered at any time, they should receive prompt and immediate attention, as any delay in this is liable to lead to very rapid deterioration. Very few men stop to think when they see a leaky steam pipe that such leaks represent a direct loss in horse power; they think it doesn't look very well but that is about all the attention they give it. If they would, instead of looking at it that way, only consider for a moment how much coal it takes to turn water into the amount of steam they see coming from such a leak, and recollect that every pound of coal costs money, they would see that such leaks mean a loss in dollars and cents and nothing else; and if a manager, looking at the matter in this light, should go into his power station and see such things going on, I venture to say that leaks would be stopped very quickly.

LINE REPAIRS.

I think it will be safe to assert that more than one-half the roads

in this country have no system of inspection for their lines and no repairs are made thereto until something goes down and a few dollars are lost, varying in amount, depending on how serious the damage is when the break occurs, before any attempt is made to repair the line. Suppose we pause for a moment and consider what the line represents, to what service it is subjected, and then let us see if this is not one of the most vital points in the system that needs attention. Lines that have been put up in recent years have usually been of number 0 copper, supported at intervals of about 125 feet by insulators depending from span wires or bracket arms and having attached to the insulated bolt an ear soldered hard and fast to the trolley line. This line is then hauled as taut as possible and kept in place by means of strain insulators. At every point of suspension the line is elevated a little more than elsewhere, so that when the trolley goes along at a fair rate of speed it strikes the trolley wire at the end of the ear a blow, and if the line sags down much, this blow is often quite a severe one, and as the trolley goes along under the wires it forces it up, thus bending it a little every time at the point where the ear is joined on to it. From this two dangers may arise; first, the insulation may be cracked from repeated blows, and second, the trolley wire itself may be crystallized and a crack developed in it at the point of suspension. If a crack occurs in the insulator then moisture gets in, rapid disintegration occurs until it no longer acts as an insulator, but dead grounds the trolley to the span wire. This latter may be insulated from a pole, but often is not and on a rainy day will occur a leak which, while not very great at any one point, may amount to considerable on several miles of line. To avoid these casualties a system of inspection of the line should be followed out, which should include a testing for insulation and a going over the line with a tower wagon at stated intervals for the purpose of making a critical examination of the lines in person. Every road, we may assume, is provided with some kind of a tower wagon. There are many kinds in the market, but many of them are extremely cumbersome and make more noise than a Calithumpian band as they go along the street. The neatest tower wagon that I have ever had the pleasure of seeing was one that was shown me on a recent trip I took down East. This was designed by the general manager of the Portland Street Railway, and occupies no more space than an ordinary two-horse team, while the tower part itself lowers down into the wagon body by means of several pieces of timber joined together like a pair of scissors, and is raised up very easily and quickly by means of an ordinary winch handle geared about 3½ to 1. The tower wagon being essentially an emergency wagon, similar to a police patrol wagon in a large city, should be built with the end always in view that when it is wanted it is wanted in a hurry and it cannot get to the spot too fast; for that reason men should always be detailed ready to go on it at any moment, and horses should be kept in readiness for this service alone if the road is a large one. On the wagon should be carried two boxes, one containing the necessary tools to make the repairs, and the other the materials with which to make the repairs except that the coils of wire may be slung underneath the wagon.

TRACK REPAIRS.

The track is another portion of the system which often receives scant attention and very few roads have any regular system of track inspection to see that it is in proper condition. We note that the long experience of steam roads has shown them the absolute necessity of having their tracks in perfect condition at all times, and they have found it a matter of economy to employ track walkers to go over the tracks at stated intervals to make a careful and thorough inspection of every joint, rail, tie and spike. Except in large cities where there is a great amount of traffic, it is hardly necessary to adopt such a very rigid course as this, and the wear and tear of the track is not such as to require it, but it would be economy to have a man go over the track about once in two weeks and examine each joint, noticing particularly how much more motion there is in a joint when a car goes over it; there should of course be just as little as possible, and if the track inspector notices any movement he should make a record of this particular joint and the track gang should attend to it at once, as this is the vital point in the life of the rail, and if the movement is allowed to continue for any length of time the joint becomes battered and the damage to the rail increases very rapidly. One good plan to avoid this tendency to give way at the joint is, in laying the rails to place underneath the joint a plate of ½ inch iron which serves to prevent the rail biting into the tie; then rock ballast the ties at the joints and keep them well tamped up to place, where the rails are spiked directly on to the ties. In case stringers are used, they can be cut away at the joints sufficiently to allow the iron plate to be placed under the rails, and then if attention be paid to keeping the stringers well lined up, the motion at the joint will be sm . A good many that objected to the use of iron plates, stated that it causes a more rapid running of a tie or stringer, but from the best opinions that I have been able to gather, I do not find this to be so, in fact, just the reverse, for the biting process due to the ends of the rails resting directly on the ties or stringers is more destructive than the rotting incident to the use of the iron plate, and it is certain that the iron plate makes a bed for the end of the rail which eventually prevents any great movement of the joint. There is one other point in the track repairs that is beginning to call for special attention, and that is, the maintenance of the rail bond. We find that where there is much movement of the joint the rail bond is rapidly worn out, due to the sawing motion which the rail exerts on the bond as it rises and falls. Therefore, to avoid this, it is necessary to go back far enough away from the joint so that no perceptible motion will be felt. In other words, to avoid this difficulty, we should bond our rails back 2½ or 3 feet from the joint; this of course means more copper at first and a greater cost, but if the rail is properly bonded in the first place and attention paid to this point and the use of double bonds of sufficient size, it would seem as though we need not apprehend much trouble from this source. I ran across a road a little while ago which avoided the bonding question entirely, practically speaking, by depending on their fish plates, supplemented by a copper washer under the bolt heads for the transmission of their current by the rails. I endeavored to convince the superintendent that this was not the proper method, but I regret to say my powers of argument were not sufficient to overcome his tenacious ideas on the subject; therefore, he will have to learn the lesson by experience, the same as others have done, that a proper bonding of the track in the first place, with careful attention to it afterwards, and the maintenance of the track and road bed in good repair, are two of the greatest economies that can be practiced in the operation of a street railway system.

In conclusion, I would state, that the whole sense of this article can be summed up in the few words of an old adage, "A stitch in time saves nine."

Electricity and Whiskey.

A correspondent of London "Lightning" asks how to apply an electric current to the purification of well water, the objection to this water being that it turns whiskey black. The editor of that journal remarks that the writer has by no means proved that the water is at fault and suggests that he look to his whiskey as well, as poor sorts of whiskey may contain sulphuretted hydrogen or tannin, which blacken iron salts. If the electrical treatment should prove to be too expensive, he recommends the American method of consuming the whiskey and water separately, and adds that he need not fear that the black compound will form in his own well, as the presence of the gastric juice will prevent the formation of any black iron sulphide.

Cost of Electric Traction.

From a discussion of a paper read in London, it appears that the cost of power and traction on the Marseilles electric line, which has gradients as high as one in sixteen, is a little over 6 cents per train mile, coal costing $5 per ton; at Florence with continuous grades up to 1 in 20 and 1 in 12.5, it is 8 cents, coal costing $7.50 per ton; at Budapest and other lines in Europe, 8 cents covers the entire working expenses; on the Liverpool line the total working expenses are 27 cents per train mile, which is 86 per cent. of the receipts.

Compressed Air Traction.

A reservoir recently burst in one of the cars of a compressed air line in the streets of Paris, but the passengers escaped uninjured. One of the many advantages of electricity over compressed air traction is that electricity does not burst, and passengers on trolley cars need therefore not be in constant fear that there is something like a dynamite bomb directly under the seat on which they are sitting.

Lowering the Candle-power of Lamps.

The idea of switching two lamps in series when a dim light is required, such as a bedroom night light, has been reinvented many times. Our bright contemporary, London "Lightning," in referring to this, remarks that there is touch of humor in Messrs. Rawlings' device of putting one lamp out of sight to satisfy a public that "cannot understand why two lamps should be used when one is more than they want."

Electrodynamic Machinery—XII.

BY E. J. HOUSTON AND A. E. KENNELLY.

55. It is important to remember that the entire conception of metallic reluctivity is artificial; although very convenient for purposes of computation, yet, as already pointed out, it is incompetent to deal with the case of residual magnetism. Thus, if the prime M. M. F. in the ring be withdrawn, we should expect the flux to entirely disappear, whereas we know that a large proportion will generally remain. Since, however, electro-dynamic machinery rarely calls residual magnetism into account, the reluctivity theory is adequate for practical purposes beyond critical magnetizing forces.

56. As another illustration, let us consider a very long rod of iron, wound with a uniform helix. Here, as we have already seen disregarding small portions near the extremities, the intensity may be regarded as uniform within the helix. Since the reluctance of the external circuit may be neglected, this flux density, as we have seen, is 1.257 $n\,i$, gausses, where n, is the number of loops in the helix per centimetre of length, and i, is the exciting current strength in amperes. Or, regarding the intensity as the gradient of magnetic potential, which changes steadily by 1.257 $n\,i$, per centimetre (this

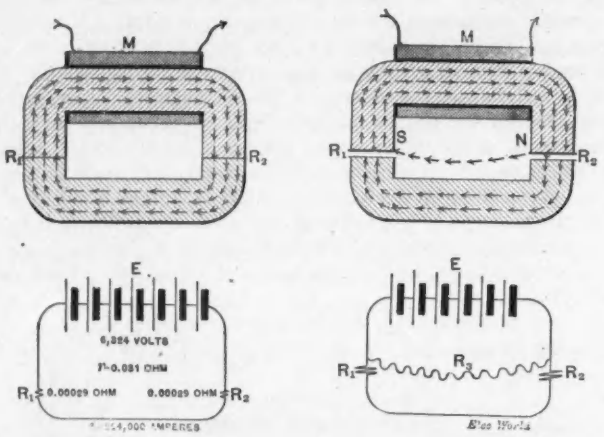


FIG. 48 AND 49.—DIAGRAMS REPRESENTING A SIMPLE FERRIC, AND AN AERO FERRIC, CIRCUIT, AND THEIR ELECTRIC ANALOGUES.

being the number of gilberts added in the circuit per centimetre of length), the fall of potential or drop in the external circuit being negligible, the gradient within the helix is 1.257 $n\,i$ gausses as before. A rod of Norway iron one meter long and 2 cms in diameter, wound with 20 turns of wire to the centimetre, carrying a current of one ampere, would, at this magnetizing force, have an intensity in it of approximatly $1.257 \times 20 \times 1 = 25.14$ gausses. The reluctivity of Norway iron would be by the preceding formula $\nu = 0.0004 + 0.000057 \times 25.14 = 0.001,833$ or about 1-500th of air. The length of rod being 100 cms, and its cross section 3.1416 square cms, the reluctance would be approximtaely $\frac{100}{3.1416} \times 0.001,833 = 0.05836$ oersted. The total M. M. F. being $100 \times 20 \times 1 = 2,000$ ampere-turns $= 2,514$ gilberts. The flux in the circuit, assuming that the reluctance of the air path outside the bar may be neglected, is approximately $\frac{2,514}{0.05836} = 43,070$ webers, with an intensity of $\frac{43,070}{3.1416} = 13,710$ gausses.

57. In cases where the flux is confined to definite paths, as in a closed circular coil, and in a very long straight and uniformly wrapped bar, the preceding calculations are strictly applicable. When, however, an air-gap is introduced into the closed ring, that is, when its circuit becomes aero-ferric, the results begin to be vitiated, partly owing to the influence of diffusion, and partly owing to the results of the counter M. M. F. which is established at the air gap. As the length of the air-gap increases, the degree of accuracy which can be attained by the application of the formula diminishes, but in dynamos, the aero-ferric circuits are in almost all cases of such a character, that the degree of approximation, which can be reached by these computations, is sufficient for practical purposes; for, while it is impossible strictly to compute the magnetic circuit of a dynamo by any means within our present reach, yet the E. M. F. of dynamos, and the speed of motors, can be predicted by computation within the limits of commercial requirements.

58. If the ring of Fig. 45 be provided with a small air gap of 0.5 cm in width, the intensity in the circuit before the introduction of the iron core will be practically unchanged by the existence of the gap, that is to say, with the same 1,000 ampere-turns, or 1,257 gilberts of M. M. F., the intensity existing in the ring will be practically 20.95 gausses. In the air-gap itself, the intensity will be less than this, owing to lateral diffusion of the flux; and, neglecting these influences, we may consider the intensity to be uniform. Now, introducing a soft, Norway iron core into the same air gap, the iron is subjected to an intensity of approximately 20.95 gausses throughout the circuit. The reluctivity of the iron at this intensity, is, as we have seen, 0.001,596. The length of the circuit in the iron will be 59.5 cms., and its cross section 10 sq. cms, making the ferric reluctance $\frac{59.5}{10} \times 0.001594 = 0.009,484$ oersted. The reluctance of the air-gap, neglecting the influence of lateral diffusion, will be $\frac{0.5}{10} \times 1 = 0.05$ oersted, and the total reluctance of the circuit will, therefore, be $0.009484 + 0.05 = 0.059484$ oersted. The flux in the circuit will, therefore, be $\frac{1,257.}{0.059484} = 21,130$ webers, and the intensity in the iron 2,113 gausses. The existence of the air-gap has, therefore, reduced the flux from 131 kilowebers to 21 kilowebers.

59. In practical cases, however, the problem which presents itself is not to determine the amount of flux produced in a magnetic circuit under a given magnetizing force, but rather to ascertain the M. M. F., which must be impressed on a circuit in order to obtain a given magnetic flux. When the total required flux in a cicruit is assigned, the mean intensity of flux in all portions of the circuit is approximately determinable, being simply the flux divided by the cross section of the circuit from point to point. What is required, therefore, is the reluctivity of iron at an assigned flux density and this we now proceed to determine.

From the equations $S\,\nu = a + b\,\mathfrak{C}$, and $\mathfrak{B} = \frac{\mathfrak{C}}{\nu}$, corresponding in a magnetic circuit to $i = \frac{e}{\rho}$ in the electric circuit, i, being the electric flux density or amperes per sq. cm. and ρ, the resistivity, we obtain, $\nu = \frac{a}{1 - b\,\mathfrak{B}}$

This equation gives the reluctivity of any magnetic metal for any value of the flux density $\mathfrak{C}$, passing through it, when the value of the constants a, and b, have been experimentally determined. The values of ν, so obtained are only true for reluctivities beyond the critical value where the linear relation expressed in the equation $\nu = a + b\,\mathfrak{C}$ commences.

60. Fig. 47 shows curves of reluctivity of various samples of iron and steel at different flux densities. The descending branches are of practically little importance in dynamo electric machinery. They are included in the curves, however, in order to bring them into coincidence with actual observations. It will be seen that while the reluctivity of Norway iron is only 0.0005 at 8 kilogausses, that of cast iron is commonly about 0.010, or twenty times as great.

61. In order to show the application of the above curves of reluctivity we will take the simplest case of ferric circuit; namely, that of a soft Norway iron anchor ring, as shown in Fig. 44, of 10 square centimetres cross section and 60 cms mean circumference, uniformly wrapped with an insulated wire coil. If it be required to produce a total flux of 180 kilowebers in this circuit, the intensity in the iron will be 8 kilogausses, and, by following the curve for Norway iron, in Fig. 47, it will be seen that its reluctivity at this density is 0.0005. The reluctance of the circuit, therefore, will be $\frac{60}{10} \times 0.0005 = 0.003$ oersteds, and the M. M. F. necessary to produce the requisite magnetic flux will be $\mathfrak{F} = \phi\,\mathfrak{R} = 80,000 \times 0.003 = 240$ gilberts, or $240 \times 0.7958 = 191$ ampere turns.

62. If, however, the ring be of cast, instead of soft Norway, iron, its reluctivity at this density would be say 0.010, and its reluctance $\frac{60}{10} \times 0.010 = 0.06$ from which the required M. M. F. will be $80,000 \times 0.06 = 4,800$ gilberts $= 3,820$ ampere turns. The importance of employing soft iron for ferric magnetic circuits, in which a large total flux is required, will, therefore, be evident.

63. Fig. 48 is a representation of a simple ferric circuit consisting of two closely fitting iron cores, the upper of which is wrapped with a magnetizing coil M. The polar surfaces are made to correspond so closely, that when the coil M has a magnetizing current sent through it, the magnetic attraction between the two cores will cause them to exclude all sensible air gaps. The general direction of the flux paths is shown by the dotted arrows, and a mechanical stress is exerted within the iron along the flux paths.

These stresses cannot be rendered manifest, so long as the iron is

continuous. In other words, the continuous anchor ring, as shown in Fig. 44, would give no evidence of the existence of stress along its flux paths. In the case shown in Fig. 48 the stress is rendered evident by the force which must be applied to the two magnetized cores in order to separate them. The amount of this force depends upon the magnetic intensity in the iron at the polar surfaces, and, if $\mathfrak{G}$, represents this intensity, the attractive force exerted along the flux-paths at the polar surfaces, *i. e.*, perpendicularly across them, will be $\frac{\mathfrak{G}^2}{8\pi}$ dynes per square centimetre of polar surface. The dyne is the fundamental unit of force employed in the system of units universally employed in the scientific world, and is equal to the weight of 1.0203 milligrammes at Washington; that is to say, the attractive force which the earth exerts upon one milligramme of matter is approximately equal to one dyne.

64. If the magnetic circuit shown in Fig. 48 has a uniform area of cross section of 12 square centimetres, and the magnetic intensity in the circuit be everywhere 17 kilogausses, then the attractive force exerted across each square centimetre of the polar surfaces at R_1, and R_2, will be

$$\frac{17{,}000 \times 17{,}000}{8 \times 3.1416} = 11{,}500{,}000 \text{ dynes.}$$

or $11{,}500{,}000 \times 1.0203 = 11{,}730{,}000$ milligrammes weight $= 11{,}730$ grammes weight $= 25.86$ lbs. weight.

As there are twelve square centimeters in each polar surface, the total pull across each gap will be $12 \times 25.86 = 310.32$ lbs. weight; and since there are two gaps, the total pull between the iron cores will be 620.64 lbs. weight, so that, if the whole magnet were suspended in the position shown in Fig. 48, this weight should be required to be suspended from the lower core (less, of course, the weight of the lower core) in order to effect a separation; or, in other words, this should be the maximum weight which the magnet could support.

65. In order to ascertain the M. M. F. required to produce the required intensity of 17 kilogausses through the circuit to cause this attraction, we find, by reference to Fig. 47, that the reluctivity of Norway iron at this intensity is 0.0073; *i. e.*, $\frac{73}{10{,}000}$ that of air. The reluctance of the magnetic circuit will, therefore, be $\frac{50}{12} \times 0.0073 = 0.03042$ oersted. The total flux through the circuit will be $17{,}000 \times 12 = 204{,}000$ webers, and the M. M. F. required to produce the flux, therefore, will be $204{,}000 \times 0.03042 = 6{,}206$ gilberts, or $6{,}206 \times 0.7958 = 4{,}937$ ampere turns. If, then, the coil M, has 2,000 turns, it will be necessary to send through it a current of 2.469 amperes, in order to produce the flux required.

The electric circuit analogue of this case is represented in the same figure, where E represents the E. M. F. in the electric circuit as a voltaic battery, and the amount of this E. M. F. necessary to produce a current of strength i, amperes when the total resistance of the circuit is r, ohms will be $E = ir$ volts.

66. So far we have considered that no sensible reluctance existed at the polar surfaces R_1, and R_2. Practically, however, it is found that, no matter how smooth the surfaces may be, and, therefore, how closely they may be brought into contact, a small reluctance does exist, owing, apparently, to the absence of molecular continuity.

This reluctance has been found experimentally, in case of very small joints, to be equivalent to the reluctance of an air gap, from 0.003 to 0.004 cm wide (0.0012″ to 0.0016″.) Taking this reluctance into account we have at R_1, and at R_2, an equivalent reluctance of air path, say 0.0035 long and 12 cms in cross sectional area. Since the reluctivity of air is unity, the reluctance at each gap becomes $\frac{0.0035}{12} \times 1 = 0.00029$ oersted, and the reluctance of the circuit has, therefore, to be increased by 0.00058 oersted, making a total of $0.03042 + 0.00058 = 0.031$ oersted, and requiring the M. M. F. of $204{,}000 \times 0.031$ of 6,324 gilberts $= 5{,}032$ ampere turns, or an increase of current to 2.516 amperes.

(To be continued).

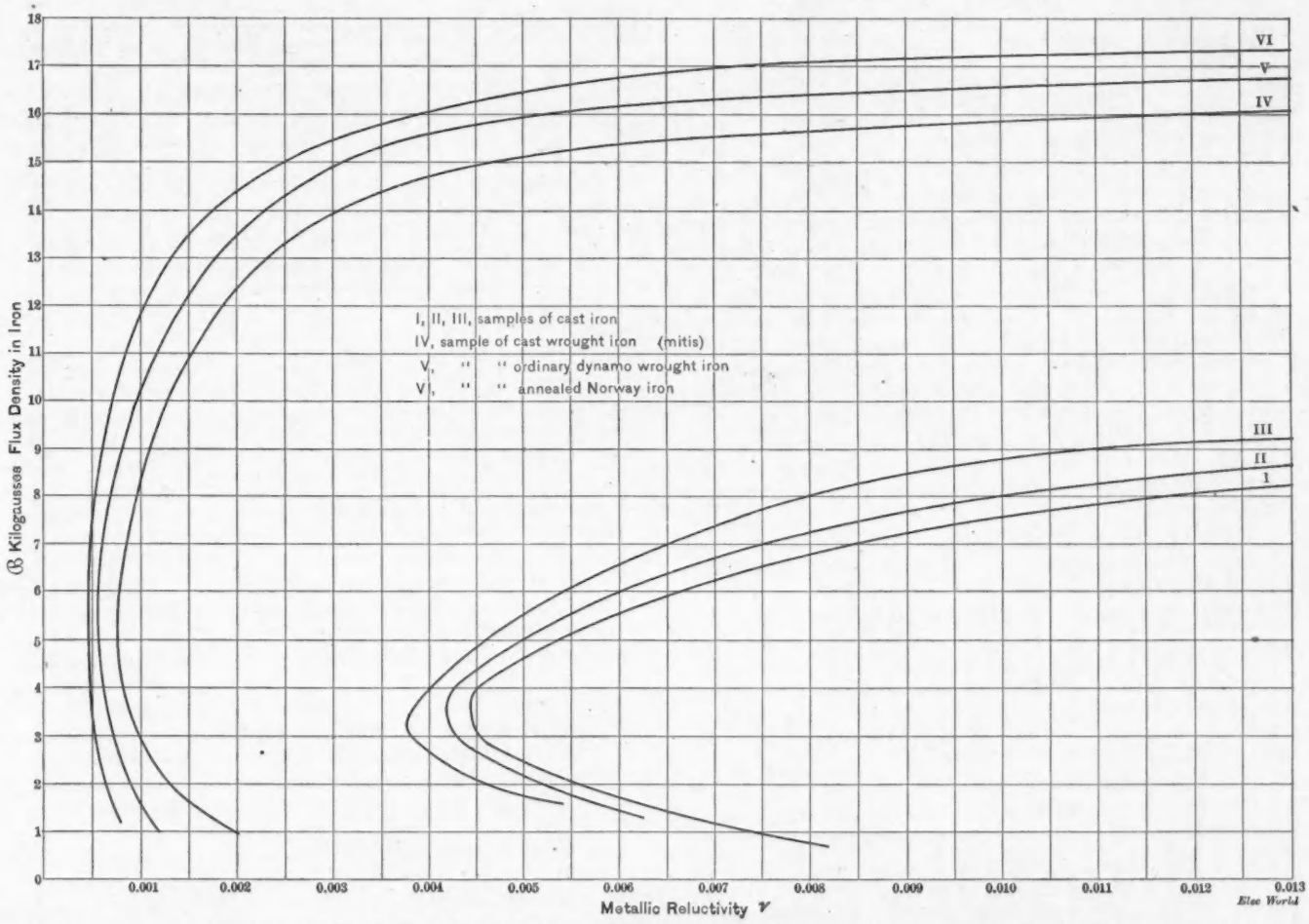


FIG. 47.—CURVES OF METALLIC RELUCTIVITY IN IRON IN RELATION TO FLUX DENSITY, FROM OBSERVATIONS BY ONE OF THE WRITERS. ORDINATES, RELUCTIVITY, ν; ABSCISSAS, FLUX DENSITY $\mathfrak{G}$.

An Expensive Joke.

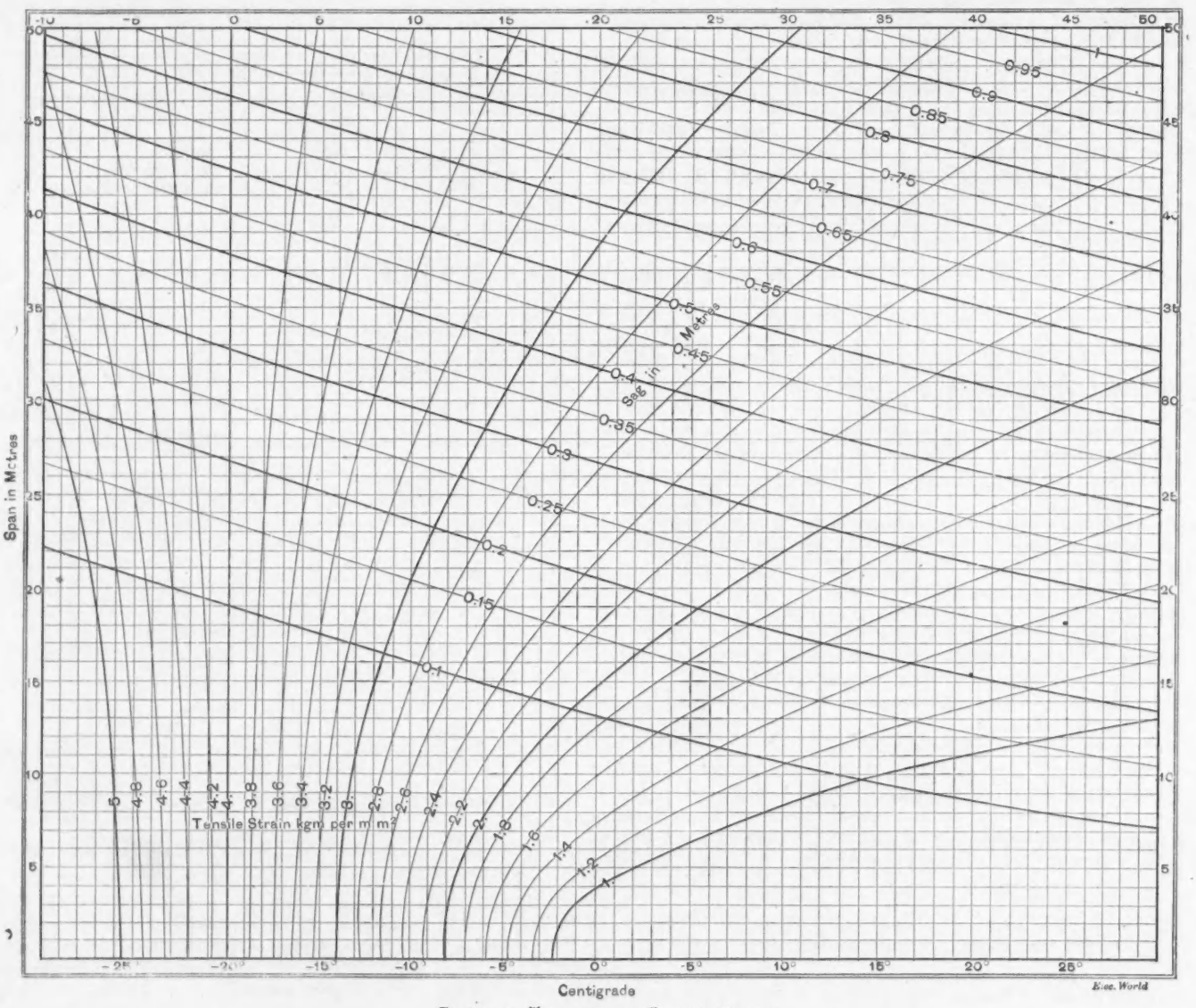
The exhibitor of an "Electric orchestra" in a city in Germany, connected one of the chairs of the audience with an electric circuit in such a way that any one sitting down on it immediately rose again with a jump, much to the amusement of the audience. One of the audience, however, who did not appreciate the joke, took the matter to court and was awarded $75 damages.

The Sag of Copper Lines.

In a paper "On the Sag of Soft Copper Wires Freely Suspended," of which we have received proof sheets, Mr. Josef Herzog, of Budapest, makes an elaborate study of the subject with particular reference to copper wire.

The condition laid down is that the wire should be strained only so far that with a decrease of temperature there will occur no stresses which, when the temperature again increases, would lead to abnormal sagging. From the various equations deduced, curves were plotted by means of which the sag may be determined for any case. In the figure below, which we reproduce from Mr. Herzog's paper, the horizontal lines correspond to the length of span in metres and the vertical lines to temperature in degrees centigrade. The curves starting from the bottom represent the tension in kilogrammes per mm², and the intersecting curves the sag in metres.

As an example of the application of the curves, suppose we wish to know the most desirable sag of a wire with a span of 40 metres and at a temperature of —12 C. It will be seen that the intersection of the 40 metre horizontal line and the —12° vertical line falls very near to both the 0.5 metre sag curve and the 3.6 kilogramme tension curve. The sag at —12°C will therefore be 0.5 metres and the tensile strain 3.6 kilogramme per mm². At a temperature of 30°C, we similarly find that the sag of the same line would be about .78 metres and the tensile strain 2.3 kilogrammes per mm². By these curves, therefore, the sag and tensile strain for any temperature may be determined. The author states that the latter should not exceed 4 kgm per mm².



Sag and Tension of Copper Lines.

White Reflectors.

According to London "Electricity" a perfect dead white reflector of one square foot, illuminated with π candle-foot emits one candle-power normally.

The Worcester Polytechnic Institute.

The Worcester Polytechnic Institute begins its work this year under promising conditions. The electrical classes in particular, both graduate and under-graduate, are larger than ever before in the history of the school. Dr. T. C. Mendenhall, who last summer resigned his position as Superintendent of the U. S. Coast survey and accepted the presidency of the Institute, has just returned from Europe and will enter upon his work at once. The Worcester school is to be congratulated upon having secured for its leader one who is so well known as as an able administrative officer and as a distinguished scientific scholar. Instruction in electrical engineering at the Worcester Institute is given during junior and senior years, and an advanced course of study and work for graduates is also provided. The laboratory has for experimental work fifteen dynamos and motors of various types, including a complete A. C. station outfit, with transformers and lamp load for 500 lights. It is wired for the 50-volt A. C. current, also for the 500-volt current from the power circuit of the Worcester Electric Light & Power Company. It has a storage battery of 250 20-ampere hour cells and a variety of single cells for special uses. It is also well furnished with instruments for standard and commercial measurements. Five rooms in the Salisbury Laboratories, with an aggregate floor space of 7,000 square feet, are used for electrical work, in addition to lecture rooms and an isolated stone building for work requiring special accuracy. An important feature in this course is the station work, which the courtesy of the directors of the local Electric Light & Power Company has enabled this department to offer. The students, under the direction of an instructor, are allowed to observe the methods and to study in detail the machinery and wiring of the establishment. until each one has had an opportunity to trace and chart the whole installation from the boiler-room to street lines. The electrical engineering department of the Institute is under the direction of Prof. A. S. Kimball.

Fly Wheel Accidents in Power Stations.

To the Editor of The Electrical World:

Sir:—The conditions described in the letter of Mr. Coykendall on fly wheel accidents are unquestionably likely, even certain, to occur occasionally, perhaps frequently. Their existence would as certainly introduce overload and risk, and I think it extremely possible that they may have been the occasion of some of the accidents which have come to be common since the introduction of the electric current for transmission of power.

The breaking of a fly wheel and the consequent wrecking of an engine is not a recent innovation or an accident confined solely to electric power-stations. Numbers of such wrecks have happened in cotton mills and rolling mills, and they may be met with in any engine room in which an engine with detachable valve gear is in operation. Every case that I have known has been the breakdown of machines of that class. Liability to the accident from the causes to which our attention is here called—sudden excess of current at the driven dynamo—is equal with all classes of engine. In such cases, the instantaneous application of abnormal resistance, if the wheel be weak, is liable to throw upon its arms a proportionally excessive load, and the wheel may go to pieces. But, I think, in most cases, the belt would slip before the over strain could reach the danger limit, and where this might not occur, if the wheel were properly proportioned and given a good "factor-of-safety," it would usually carry the load until it reached such a limit that the provision at the dynamo, the circuit breaker or fuse, or some other limit to rising voltage or current, would be affected, and the crisis would be safely passed. The fact that so few such accidents occur with high-speed engines would seem to indicate this to be the case. But a weak wheel, on either class of machine, would be apt to yield to such treatment as your correspondent describes.

In such accidents as I have known, of the class referred to, the engine is found, after the break-down, to have had its governor deranged and, presumably, this has been the cause of the accident. A belt slips or breaks, or the key comes out of the governor pulley, or the engine is relieved so suddenly and completely of its load that the charge of steam just taken into the cylinder is sufficient to accelerate its speed to the danger-point with a weak and faulty wheel. The conditions of operation of the engine in electric light and power stations are peculiarly favorable to the production of such accidents. The enormous variations of power, often from no load to an excessive load, in an instant, and the constant changes of load are sure to result in a constant jerking and shaking of the whole machine, and especially in the governor system. And this rattling of the governor pulley, if the key be not driven hard, and the shaking of its belt, make it certain that, sooner or later, something will get loose. If it shakes out the key, the result is pretty certain to be disastrous; if the governor belt simply slips, danger follows, if not disaster; if the belt breaks, the engine is gone.

Another seldom-noted danger is that resulting from the fact that many governors are not so designed and built as to be capable of acting effectively, in these cases of exceptionally rapid rise in speed of rotation. Mr. Porter discovered, proved, and promptly published the fact, many years ago. He found that the sudden jerk of the governor, in such instances, might cause the arms to bind on their pins, or in their sockets, in such manner as to render them nearly or quite inoperative, and thus to introduce the superlatively dangerous condition of a governor working satisfactorily on all ordinary occasions, and awakening no suspicion, and finally, when its services are most needed to prevent a possibly destructive and fatal accident, refusing to work at all. He introduced his loaded governor, with widely separated pivot-points at the extremities of the arms, to evade this serious risk.

Every drop-cut-off engine, on such duty—in fact, I am inclined to say, every engine with detachable valve-gear, without regard to kind of duty—should have some automatic system of detachment, at a stated limit of speed in excess of the normal, and this "knock-off" is, I think, now considered an important feature in every plant of this character. With a well-designed, well constructed wheel, free from such flaws as have distinguished some of those which have gone to pieces in late years, and guarded by proper automatic devices at engine and dynamo, the danger of this form of accident becomes, or may be made, insignificant.

The danger, in case of short circuiting of the dynamo, is ordinarily reduced by the fact that, in most cases, the power is transmitted from engine to dynamo through a pulley-fly-wheel, and the tendency is thus always to put a brake upon the wheel in the most effective and safest manner, while the slip of the belt adds security. The only shock, in such a case, comes mainly of the inertia of the reciprocating parts of the engine, and then only when near the half centre. "On the centres," no such shock can occur. Where, however, as in some European practice, particularly, the power is transmitted from a separate driving pulley and the fly wheel is not belted, the danger is greater in consequence of the fact that the surge, with sudden checking due overload, takes effect upon the arms of the fly-wheel in the most trying manner, and irrespective of the position of the working parts, which, in such case, assist by reducing, rather than intensifying, the shock. This latter is also the case of the directly-connected dynamo, now becoming so common an arrangement, and which is found so satisfactory in other respects.

Ithaca, N. Y. R. H. THURSTON.

To the Editor of The Electrical World:

Sir:—From my experience with short circuits, I do not think Mr. Coykendall's explanation is the best one, although it would be a rash man who would say that the wrecking of an engine cannot be caused by a short circuit, either within or outside the power station. Circuit breakers do sometimes stick, and while the generators are invariably protected by fuses in addition to the circuit breakers, the time required to blow the fuse might be sufficient for the overload to wreck the engine. To one statement of the writer I take exception. He says in the third paragraph, "The circuit is thereby broken and the engine unloaded, its speed being thereby accelerated somewhat even with the best of governors and the voltage therefore raised still more." This can hardly occur with a modern engine. Engines as built nowadays will rarely accelerate more than one or two per cent. when the load is thrown off, and with a compound wound generator when the load is thrown off the voltage will drop instead of rising if the speed remains constant, and an acceleration of one or two per cent. would not cause any material rise in the voltage.

My own opinion is, that such accidents are more apt to occur through the governor on the engine becoming inoperative from some one or another of several causes, and a case in which I was personally concerned confirms this opinion.

In a certain power station, two belt-driven railway generators were running in multiple. Without any warning, the circuit breakers went out one after another, almost instantaneously. There was an alarming display of fire works on the switch-board and on the commutator of one of the generators. The engineer at once rushed to the throttle valve of the engine driving the generator which seemed to be in trouble and shut off the steam and also shut down the other engine afterwards. Without examining the switch-board or generator he started up another pair of generators and waited the arrival of the superintendent and myself.

Several of the brush-holder springs on the generator were found burned up. The brush-holders themselves were also badly burned. The commutator looked as though it had been in a fire, and, in a word, the commutator end of the generator looked as near a complete wreck as one could conceive. On the switch-board we found that seven 120-volt incandescent lamps in series had been "blown," showing that the voltage for this machine had risen to 1,000 volts or more. The generator was cleaned up and put in shape again, and a search made for short circuits. We found none inside the station, neither had the trolley wire been on the ground or anything occurred outside, so far as we could learn, to cause a short circuit. The superintendent stood by the engineer who then started the engine. The writer went to the switch-board. As the engine and generator were started, the resistance being all in the shunt field rheostat, the voltage went rapidly to 650, seeing which I called to the engineer to shut down. An examination of the engine showed that a screw in the governor mechanism had come out, so that the governor was inoperative and steam was admitted for fully three-fourths of the entire stroke. There was but one conclusion; that the entire trouble was caused by an acceleration of speed in the engine. Now, if the fly wheel had not been made of good stuff, there would have been a wreck in that station without a doubt. Any little concealed defect in the iron and there would have been another unexplained accident.

J. S. BADGER.

Schenectady, N. Y.

To the Editor of The Electrical World:

Sir:—I do not agree with Mr. Coykendall that the prevailing accidents to fly wheels occur principally from sudden impositions of load, as stated in his article. Were such the case many branches of manufacture would be paralyzed with alarming frequency. Automatic cut-off engines have from the first been built in all their parts of sufficient strength to withstand the strains due to the sudden

release and imposition of load, even when the latter is sufficient to slow the engine very perceptibly in a few seconds and in some cases to actually "stall" it. Electrical machinery imposes no more difficult loads on steam engines, so far as safety is concerned, than were previously successfully handled in many branches of manufacture, particularly in rolling mills. I have investigated a number of cases where fly wheels have been disrupted and am satisfied that in those cases, as well as in the majority of others, the accidents were entirely due to centrifugal force arising from high speed, and necessarily involved improper action of the governor. Some wag has said of automatic apparatus, though referring more particularly to safety devices for boilers, that "The better and longer they work the more dangerous they become." Steam engine governors work so perfectly for very long periods that eventually they become neglected in some detail, such as the tightening of the belt or the oiling of the fly wheel type. In such cases the overload in connection with blowing of the fuse or the release of the automatic switch, causes the damage, not on account of the weakness of the engine, but for the reason that full steam is thrown on automatically during the overload, and when such load is suddenly released the engine increases its speed faster than the crippled governor can follow it. If everything has worked well for a long period the engineer is not particularly watchful and a fly wheel disruption results.

At the time Mr. Coykendall refers to, viz.: putting on the load after the circuit has been opened, the engine would be running at speed without load and consequently with short cut-off, so that sudden loading would simply slow it, and besides every one would be on the alert and an accident be hardly possible.

New York, N. Y. CHAS. E. EMERY.

To the Editor of The Electrical World:

Sir:—In regard to Mr. Coykendall's letter on the subject of fly-wheel accidents in electric power houses, I cannot agree with him that the direct cause of wreckage is the undue load thrown on the engine by a short circuit, though this may depend largely on whether the dynamo is on the engine shaft or connected to the fly wheel by a belt.

In the former case the sudden greatly increased resistance in the dynamo tends to check the engine speed suddenly and the stored energy in the fly wheel rim is very apt to wreck the arms first and, of course, the rim afterwards. Where, on the contrary, the dynamo is belt-driven from the fly wheel, if the belt does not succumb to the sudden strain thrown on it, it acts merely as a rim brake on the fly wheel and no harm should occur unless the belt is torn asunder. Should this happen, then the engine is off with a bound and, unless the regulator is very efficient, in a few seconds arrives at a destructive speed for any cast iron fly wheel ever built. An engine of the Corliss type, with a single eccentric and valves adjusted so as to follow to three-eighths stroke, will, unless provided with other device than the ordinary pendulum governor wreck itself every time under these conditions.

I do not believe the wreckage ever occurs from the added cylinder effort to overcome the added resistance, for there is no engine built that it would not be perfectly safe to block at half stroke and then put on full boiler pressure.

Cast iron is not suited to tensile strain and the only reason I can see for builders continuing to use it for fly wheels is that it is cheap. No bridge builder would dare to-day to put a cast iron tension member in a bridge, yet the stress per square inch of section is less in a bridge than it is in the rim of a fly wheel at the very ordinary speed of 5,000 feet per minute.

Manchester, N. H. CHAS. H. MANNING.

To the Editor of The Electrical World:

Sir:—Mr. T. C. Coykendall's comments on fly wheel accidents in Electrical Railway power stations give some conditions of load which may cause bursting of wheels. If the wheels and safety devices are properly designed for the speed and loads that may come the wheels will not burst. The lack of proper design and workmanship seems to be the real cause of such accidents; the former is dependent upon the engineer, the latter upon the manufacturer. In designing an engine for any given case one must first determine the average car load, then the possible ultimate load due to short circuits; make the cylinder dimensions as close to the point of greatest economy at average car load as the condition of maximum car load will allow and design the other parts of the engine for the ultimate load. This applied to the fly wheel problem must take into consideration the possible changes in speed, applying the necessary safety devices to shut off steam in case of an excessive increase and sufficient strength of parts to take up the energy due to sudden increase of load causing a reduction in speed.

An example of this method of design and manufacture is that of the engines in the power-house of the Derby Street Railway, Derby, Conn.; the engines are 18x30. All are Corliss direct connected to 200 kw General Electric Generators each rig making 150 r. p. m. (750 ft. piston speed per minute); average car load 100 to 125-hp; economical load of engines 225 hp; safe load for 24 hour runs 400 hp; while ultimate load of 550 hp would not break down the engines; besides the governor cut-off there is an automatic cut-off valve above the throttle which closes between any set limits of speed. In this case it will be noticed the large difference between average car load (125 hp) and economical load of engines (225 hp) is due to heavy grades with all cars ascending at the same time.

Were the above method generally followed we would not hear of bursted wheels or wrecked engines except from causes beyond our control. CHARLES HENRY DAVIS.

New York, N. Y.

To the Editor of The Electrical World:

Sir:—It appears to me the hypotheses advanced by Mr. Coykendall are sound and, would undoubtedly afford an explanation of many of the destructive accidents to central station fly wheels, which are now of such common occurrence. It seems to me, however, that the opening of the automatic cut-out in the central station should be regarded by the station engineer as a danger signal, and that the cut-out should not be replaced immediately without a slight investigation of the conditions of the lines and station machinery, which would obviate throwing upon the engines the sudden loads of which mention is made.

In my own practice, in the construction of some three hundred miles of electrical railway, I made it a point to place tell-tale lamps in all the circuits in such a way that the engineer could rapidly make a measurement of the circuit resistance and determine whether, or not, a short circuit continued, to exist. In many cases, the throwing of the automatic was simply due to a sudden extra current, the circumstances causing which were removed before the engineer could make the necessary line test. Therefore, when the lamp rheostat was thrown on the line, it indicated the normal condition and the circuit breaker was replaced. It will naturally be advanced that such a proceeding as this involved a few moments' stoppage to the operation of the road, which is perfectly true, but in the stations of which I speak all the machinery was designed to carry forty per cent. of overload with ease, and the cicriut breakers were adjusted so that they would not open unless this maximum was reached. If the circuit breakers opened, the engineer might understand that some serious cause had affected the circuits and therefore would not replace them until he ascertained that the difficulties had been cleared away.

Chicago, Ill. A. V. ABBOTT.

To the Editor of The Electrical World:

Sir:—I do not believe that the breakage of fly wheels is due to the cause which Mr. Coykendall assigns. From investigations I have made in a number of cases, I believe it is due to the following causes:

Most of these accidents have occurred, as far as my observation has gone, in stations where there are several generators independently and separately belted to Corliss engines. There is no question of the advantage of large units independently connected, either by belting or direct mounting on shaft of engine, but it has led in a number of cases to considerable trouble, and has been, I believe, the real cause of accidents where these engines do not closely balance with one another in their regulation, and get so far out in some cases as to cause a reversal of the generators, and thereby lead to a combination of circumstances causing breakage of a fly wheel. I have seen engines on work of this kind with variation as high as 6 or 8 per cent.

Fly wheels in many cases are not properly proportioned, well designed, or built to give good fair regulation under the trying conditions of railroad work. The remedy is easily to be found in better proportioned and heavier fly wheels, made of better material, and the engine so built as to give close regulation. I do not think that it can be shown that there is any station where such an accident as referred to occurred in which the engines are giving a fairly close regulation (within 3 per cent.) and where the wheels have been properly proportioned to the work to be done.

New York. C. J. FIELD.

To the Editor of The Electrical World:

Sir:—Mr. Coykendall's letter on fly wheel accidents in railway power plants contains an interesting suggestion. His argument is that the fly wheel breaks owing to the sudden application of excessive load to a wheel having great momentum, by the closing of a circuit breaker opened by a short circuit which is still existent at the time the breaker is closed.

It is more usual to consider the strain on the fly wheel to be caused by the sudden withdrawal of the heavy load (due to the short circuit when the breaker is open. In either case the point is the instantaneous change from full to no load. With an experience since 1886 the writer has never known of a fly wheel accident which could be attributed to any such cause. Time and again he has seen circuit breakers open and shut till the engine "staggered," but never with any apparent harm to the engines. The usual danger feared is from burning out of the armatures.

Will Mr. Coykendall favor us with a list of the accidents where he surmises his explanation would hold, and tell us if he thinks the proportion of bursting fly wheels in street railway plants exceeds or anywhere near equals that, say, in mill work. In the list of street railway accidents will he please state the size, make, etc., etc., of engines and wheels, as the safety factors for slow and high speed work are not the same. J. STANFORD BROWN.

New York, N. Y.

To the Editor of The Electrical World:

Sir:—Regarding the letter of Mr. Coykendall with reference to the breaking of fly wheels, I would say that in general I agree with the opinion expressed. I think, however, that when a short circuit occurs on the line and the station attendant closes the circuit breaker, the fuses should be kept in such condition that they will immediately blow out and protect the generator and relieve the load on the engine. I think the trouble is due primarily to the use of slow speed engines running one generator. In such a combination suppose, for example, that at the beginning of the stroke the load is very light, the cut-off works quickly, steam admission to the cylinder is stopped, and a short circuit occurs on the line, the fly wheel being depended upon for the power required, and vice-versa. If the load is heavy at the beginning of the stroke and then suddenly relieved, there is more steam in the cylinder than is necessary to do the work and the fly wheel must be depended upon to counteract it. Both of these cases cause a great strain on the fly wheel, the amount of which we cannot determine. I am neither a believer in high speed nor low speed engines for railway work and I think that an engine running from 120 to 150 revolutions per minute will give the best results, as it gives the governor a better chance to help relieve the sudden changes of load; and, at the same time, such an engine can be built so as to be economical of fuel.

New York, N. Y. L. W. SERRELL.

To the Editor of The Electrical World:

Sir:—The statement of causes in the letter of Mr. Coykendall as to fly wheel accidents seems to me correct. He has not, however, mentioned one of the most fruitful sources of accident, i. e., a very greatly increased centrifugal force due to the running away of the engine when the full load is suddenly removed from it. It is my opinion that, both as regards safety and as regards economy in operation, the fly wheels on street railway engines have been made too light in the past. An extremely heavy fly wheel is desirable as a means of storing energy so as to cause a tolerably uniform steam cut off, notwithstanding rapid and violent fluctuations in the load. To make these heavy fly wheels so that they shall have sufficient strength for the extraordinary strains possible in railway practice, the wheels should be cast in sections so that each spoke with its section of the rim is a separate casting, and the castings should be then all properly bolted together. Or else the fly wheels should have a solid web made of boiler iron, and a rim similarly built up of boiler iron riveted together.

New York, N. Y. H. WARD LEONARD.

To the Editor of The Electrical World:

Sir:—I do not consider that a suddenly applied load is likely to cause the breaking of fly wheels. It is true that there is a very heavy load thrown upon a generator switched in on a short circuited line under full voltage. If this load is transmitted to the fly wheel through an elastic belt capable of slipping on the pulleys, the cushion thus obtained is sufficient to leave a large margin of safety ordinarily. In the case of direct coupled generators and engines there is nothing but its own inertia tending to wreck the fly wheel. In all cases the inductions of the armature, series fields, and circuit breaker coil, do much to keep the current below the point to which it would rise if controlled by the resistance of the circuit only. I think that inherent weaknesses, damage from blows from other broken parts, and speeds above normal, are the three most probable causes of fly wheel accidents.

Lynn, Mass. MAURICE HOOPES.

To the Editor of The Electrical World:

Sir:—When an engine is suddenly loaded beyond the power of the steam pressure on the piston to move it, the accumulated work stored in the fly wheel rim takes up the load and causes a stress on the fly wheel arms similar to a beam loaded at one end and fixed at the other, in order to transmit the work in the rim to the shaft and thence (unless the fly wheel is a band wheel) to the machine driver. Vice-versa, when an engine is suddenly unloaded the work of the steam is stored in the fly wheel until its maximum speed is attained, putting a similar stress in the opposite direction on the fly wheel arms. See for mathematical discussion of this *The Relative Proportions of the Steam Engine*, by myself. WM. D. MARKS.

Philadelphia, Pa.

To the Editor of The Electrical World:

Sir:—I have no doubt that the circumstances which Mr. Coykendall describes are frequently present, and that engines are often severely over-taxed by suddenly throwing on an excessive dynamo load. Whether such conditions would be sufficient to account for any particular accident naturally depends on the particular circumstances of the case. J. LESTER WOODBRIDGE.

New York, N. Y.

Sine Form of Curves of Alternating E. M. F.

To the Editor of The Electrical World:

Sir: Since the effect of the deviation from the sine form has been realized, the question as to the best form of alternating current curves has received greater consideration. Different alternating current machines give differing curve forms, depending on the magnetic conditions. In fact, in the same machine different curves of E. M. F. can be obtained by changing the connections of the winding; and even with fixed conditions in the machine the E. M. F. curve is different in form at different loads, owing to the change in the armature current and the pulsations in the magnetizing current.

Under the many forms three characteristic curves may be distinguished:

First—The flat curve, in which form the curve rises rapidly from zero, then remains practically constant, and finally falls rapidly to zero again.

Second—The peaked curve, in which form the curve rises slowly at first, then rapidly, to its maximum value, immediately drops again, and finally falls slowly to zero.

Third—The sine curve, which lies between the two characteristic forms mentioned above.

Each of the above forms has its special advantages, so that we cannot decide on any one form without consideration of the conditions.

The amplitude, i. e., the maximum value, with the same mean pressure, is smaller in the flat curve than in the peaked curve. The insulation of the winding of the dynamos, of the conductors and cables, must therefore be higher for the peaked than for the flat form of curve. The wire space can therefore be made use of to better account when the flat curve is chosen.

The flat form is also favorable in lighting. As far as incandescent lamps are concerned, the form of the curve is of no importance, as no difference can be detected with differing curve forms. In the arc light, the form of the curve is of considerable importance. The potential difference at the carbons of a burning arc lamp, other conditions being the same, is greater in proportion as the curve is flatter. This potential difference is a function of the amplitude of the current curve. With a peaked curve this potential difference at the carbons of the lamp would be 25 per cent. less than with the flat curve. With a given potential on the line, therefore, more lamps can be connected in circuit with the peaked curve. The light produced per watt consumed in the lamp has, however, been found to be 20 per cent. less with the peaked than in the flat form of curve. The efficiency of the arc lamp is therefore greater for the flat than for the peaked form of curve.

The humming of arc lamps depends on the greater or less rapid rise in the E. M. F. curve. The steeper the rise or fall in the

different parts of the curve (the greater the value of $\frac{I\,d}{d\,t}$ in different parts of the curve), the greater will be the tendency for the lamp to hum. Hence it follows that with the use of the sine curve the lamp makes less noise than with the peaked or flat curve. If the curve is distorted by rapid steep incisions the noise becomes louder, and besides the fundamental higher tones are heard.

In transformers and motors the use of the peaked form of the curve has the advantage over the flat form in that the energy of magnetization, with the same mean E. M. F., is less. The magnetizing energy was found, for example, for an iron-clad transformer with curve forms which differed greatly from the sine curve, the ratio of amplitudes being 1.77 with the same mean pressure. When the peaked curve was used this energy amounted to 305 watts; with the flat curve it amounted to 437 watts. The energy of magnetization was therefore 43 per cent. higher on the flat curve.

It follows therefore that as far as the magnetizing energy is concerned, the efficiency of transformers and motors is higher with the peaked than with the flat form of curve. Since, however, this magnetizing energy is only a small fraction of the total energy in good motors and transformers, the efficiency is but slightly lowered.

The torque and output is not very different for different forms of curve.

The sine curve possesses special advantages in the following cases:

Through the main current in the armature E. M. F.'s are set up in the magnetic windings, as a result of which the magnetizing current is changed from a direct current to a pulsating current. This pulsating current is the sum of a direct current and an alternating current, the alternating current having double the periodicity of the armature current. With sine curve currents in the armature these alternating currents set up will also be approximately sine curves. With a simple alternating current the magnetizing current becomes

$$I = i_o + i \sin 2\phi$$

With a polyphased current these induced E. M. F.'s partly neutralize each other. For sine curve forms we would have, for example, with three-phased currents,

$$I = i_o + i \sin 2\phi + i \sin (2\phi + 120°) + i \sin (2\phi + 240°)\ i_o$$

That is to say, the pulsations in the magnet coils are weaker in proportion as the curve form of the armature current approaches the sine curve. Through these pulsations of the magnetizing current, the E. M. F. curves of the armature are distorted and the mean value of the E. M. F. affected. It follows that the effect of this magnetizing current is smaller the nearer the armature currents approximate the sine curve.

With the sine curve the combination of two such curves shifted out of place is again a sine curve. For example, the sum of two curves of the same amplitude differing in phase by 120° is equal to a curve differing in phase by 60° from the first and having the same amplitude and the same mean square.

$$e \sin \phi + e \sin (\phi + 120°) = e \sin (\phi + 60°)$$

It is therefore possible to join E. M. F.'s, and have the form

$$e \sin \phi, \text{ and } e \sin (\phi - 60°) + e \sin (\phi + 60°)$$

in parallel.

For curves that differ from the sine form of the curve, say $f(\phi)$, the sum is $f(\phi) + f(\phi + 120°)$, a curve which, if $f(\phi)$ is symmetrical, differs in phase by 60° from it, but is neither of the form, nor of the same amplitude, nor of the same mean square as the curve $f(\phi)$. If electromotive forces of the forms

$$f(\phi), \text{ and } f(\phi - 60°) + f(\phi + 60°)$$

are joined in parallel, large reactance currents are given rise to, which, as can be readily shown, have triple the periodicity of the original currents. This case arises, for example, when in using three-phased dynamos, transformers and motors, they are connected up triangularly. The reactance current is to be found also in dynamos running without load, and may become under certain conditions so large that it becomes almost equal to the normal current; as a result of which the output of the dynamos, transformers and motors is diminished and the efficiency is lowered due to the increased heating. With the use of the sine curve the reactance current, as we have seen above, becomes zero.

In order that no reactance current shall arise in plants in which the dynamos are run in parallel, the machines must have the same form of curve. Furthermore, it is to be observed that with curves differing from the sine form the diagram constructed for the combination of currents does not give accurate values, as this diagram is only correct for sine form curves. Hence we cannot replace non-sine curves by so called equivalent sine curves, that is, curves having the same mean square and which give equal values as one special sine form curve.

For example, for an E. M. F. curve whose amplitude was 1.120 of the mean value of the E. M. F., we have the following results:

	Mean E. M. F.		Amplitude.
	Observed.	Estimated.	Observed.
Simple curve	100	....	1.120
Sum of two curves differing in phase 120°	108.5	100	1.982
Difference bet. two curves diffr'g in phase 120°	167.2	173.2	1.303

The difference between the observed values and the value calculated from the diagram are so large that they must not be neglected.

In ordinary alternating current practice, dynamos with both flat and peaked curv are used. The alternating current machines of almost al. makes differ in the form of their E. M. F. curves; even dynamos from the same factory have often curves differing from each other. This lack of uniformity has great disadvantages, whereas in direct current practice the type in any well built dynamo is of no importance, such is by no means the case with alternating current machines. In alternating current practice the arc lamps must be regulated for the special curve form of the dynamo with which they are to be used; the measuring and regulating devices operate, under certain conditions, correctly, only with a given curve from; the dynamos with different curve forms cannot advantageously we run in parallel, etc. The dynamos, lamps, measuring and regulating apparatus cannot therefore, off hand, be used indiscriminately in stations having different curve forms and, in the same way, they cannot be obtained indiscriminately from any firm.

It would. therefore, be of great value if uniformity was aimed at, if all makers of alternating current apparatus would decide on some one form of current curve. The production of alternating current apparatus with a given form of curve will hardly cause any great difficulty in the present state of the art. It is an advantage to choose a curve having as simple a mathematical formula as possible. This condition is satisfied by the sine function. The sine curve might therefore be recommended as the form to be chosen as the universal current curve in alternating current practice.

Charlottenburg, Germany. SIEMENS & HALSKE.

The "London Electrician" of September 14 contains a communication from R. Shand, of Lynn, Mass., in which he states that the views expressed by that journal probably accord quite as well with the real views of Amrican manufacturers generally as do those it ventures to criticize. He believes that manufacturers in general are concerned very little with the form of wave given by their alternators, and that those with iron-clad armatures are so satisfactory that they have almost entirely superseded those having smooth core armatures. The former, in his opinion, are vastly better from a mechanical standpoint, and their possible output is from 60 to 75 per cent. greater, though they do not give anything resembling sine waves. He also believes that facts indicate the possibility of securing much higher efficiency with alternators giving comparatively irregular waves.

Trouble with Chicago Awards.

The jury awarded two prizes to the Pope at Rome and the Italian Government is now in a dilemma; if it recognizes these it will be treating the Pope as an Italian subject and if it does not recognize them it will be ignoring the distinction conferred on his two exhibits.

Clark Cells.

Mr. Skinner, in a London Physical Society Paper, has shown that the current from a standard Clark cell with 10,000 ohms in series, is far below the safe limit of current density and one need therefore not fear to take a current from such a standard cell under these circumstances.

Light for Refuse.

The town of Ealing, in England, with a population of 27,000, is about to systematically tackle the much vexed question of the destruction of the town refuse and the generation of electric light by the same plant. The results will be awaited with much interest.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM PRINCIPAL FOREIGN ELECTRICAL JOURNALS

BY CARL HERING

ELECTRO-PHYSICS.

Heat of Dissociation.—A paper by Mr. Ebert, from "Wied. Ann.," No. 10, 1893, on the heat dissociation according to the electro-chemical theory, is published in the "Phil. Mag." for September. Among his conclusions are the following: He shows that the "whole work required for the dissociation of hydrogen and iodine molecules is used in overcoming the purely electrical forces of the valency-charges;" "that the forces of chemical affinity are essentially of an electrical character; that the electrostatical forces which the charges exert on each other at the positions of valency are by far the most powerful among the forces exerted among the atoms;" and that according to von Helmholtz, "particular possible chemical forces of the charged atoms can be but infinitely small in comparison with electrical forces." "This seems of great importance for the theory of chemical forces in general."

Currents in Open Circuits, Dielectrics and Electrolytes.—A brief abstract of Mr. Nicolaieff's paper, mentioned in the Digest last week, is given with a few of the results, in the Lond. "Elec.," Sept. 28.

Action of Alternating Currents on Dielectrics.—The discussion on this subject is continued by Mr. Addenbrooke, in the Lond. "Elec. Rev.," Sept. 28, giving, however, nothing new.

Determination of Dielectric Constants.—A paper from the Italian, by Mr. Campetti, is published in "L'Eclairage Elec.," Sept. 22.

Light from Electrical Oscillations.—The "Elek. Echo," Sept. 29, publishes an article on Prof. Ebert's luminescence lamp (see Digest Oct. 6).

MAGNETISM.

Energy of Magnetization of Iron.—In an article by Mr. Peukert, in the "Elek. Zeit.," Sept. 27, he gives the formula for calculating the energy and describes a series of researches made in order to determine the connection between the work consumed in magnetizing iron, and that represented by the change of form of the iron on being magnetized; also to find whether the former finds its entire equivalent in the latter. In a series of researches, the results of which are given in tables and curves, he measures both of these quantities; he finds that with increasing magnetizations there is at first an increase in the elongation of the iron, then a maximum is reached, after which there is a continual shortening; the ratio of the two energies is given in the form of curves, the formula for which is promised in a subsequent article; it appears from this that only a very small part of the magnetization energy is represented by the work consumed in a mechanical deformation, and that, therefore, the largest part of it is transformed into heat.

Magnetic Shielding.—A short Physical Society paper, by Prof. Perry, on the simplest case of magnetic shielding by a hollow iron cylinder, is published in the "Phil. Mag.," for September. It is mathematical in character.

Equilibrium of Magnetic Liquids.—A paper from the Italian, by Mr. Mortara, of a mathematical nature, is published in "L'Eclairage Elec.," Sept. 22.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Potentiometers for Alternating Currents.—The following method by Mr. Swinburne, is described in the Lond. "Elec. Rev.," Sept. 28, for calibrating alternating current instruments by measuring or balancing against a continuous current. It is a zero method. For voltmeters the instrument is shown in Fig. 1, in which *h* is the voltmeter to be calibrated, *k* is the alternator, *e* a standard cell, and *b c* a potentiometer wire. A resistance not shown in the diagram, is placed in series with this wire to adjust the current strength; this adjustment is made so that the standard cell is balanced when contact is made at *f*, at the mark corresponding with its E. M. F. The differential electrometer is connected as shown; the double fish-tail shaped needle is pulled in opposite directions by the continuous and the alternating E. M. F.'s; the fish-tail shape is necessary to insure that the needle is in stable equilibrium when the forces are equal; there is no controlling force except that due to the suspending fibre; an instrument indicating one volt, when there is no pressure on the other side, will enable two pressures of 100 volts to be compared within one in ten thousand, and 2,000 volts within one in four million. To find the true zero of the instrument the four quadrants are connected together. Fig. 2 shows an arrangement for measuring the current, consisting of a differential dynamometer having two fixed and one movable coil, represented by *c* and *e* and by *d* respectively. There is no opposing spring to keep the movable coil in place, it being brought to zero by making the opposing forces equal. The direct current is measured by the fall of potential in the low resistance *b c*; *f* is the alternating amperemeter to be calibrated; *c* and *e* are wound close together, so that there is no appreciable time lag in any current in *c* induced by *e*, the small error due to the mutual induction of these coils canceling out; a method with no mercury contacts might be devised, in which case greater accuracy might be obtained. Mr. Blakesley pointed out that the comparison was really one of powers, which, however, does not detract from the practical value of the method.

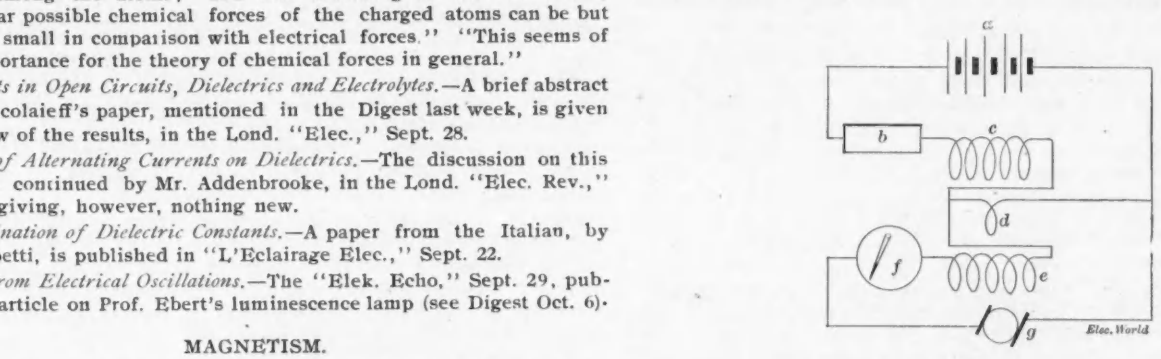


FIG. 1.

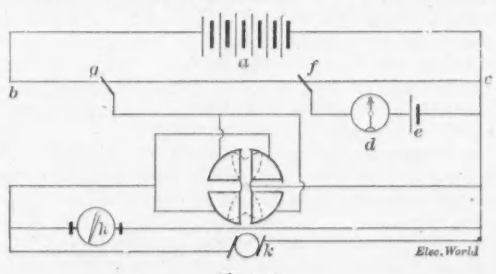


FIG. 2.

Definition of E. M. F.—In the Lond. "Elec. Eng.," Sept. 28, Mr. Giorgi contributes to the discussion on this subject, and offers the following definition: "Every current flowing in a circuit has always to overcome some oppositions, because in its flow it always generates some kind of work; therefore, it cannot be maintained unless some exterior factors, acting on the circuit, assist the flow by supplying to the current the energy it is spending elsewhere. Every one of these agents is called a source of E. M. F. It is incorrect to speak of them as sources of electricity, because electricity, like matter, cannot be generated or destroyed, but only set up into circulation. A source of E. M. F. applied to a circuit, is, therefore, everything that forces or tends to force electricity into a certain motion along the same, and in so doing it necessarily impresses a power when this motion really takes place." He discusses the subject, and states, among other things, that an electromotive force and a Newtonian or ponderomotive force are of a quite different nature, for the one acts on electricity and the other on matter; but the work done by the one in displacing electricity, and by the other in displacing matter, is absolutely of the same kind, and may be expressed in terms of the same units.

Reactance.—"L'Ind. Elec.," Sept. 25, contains an article by Prof. Blondel, in which he discusses the definition of this word, and criticises very unfavorably that contained in a recent Institute paper on reactance (by Messrs. Steinmetz and Bedell, in The Electrical World, June 30). A translation of Prof. Blondel's paper is given in full in another part of the present issue. He claims that it has not been duly recognized that this term was first proposed by the French International Society of Electricians in 1893. (The compiler calls attention here to the fact that in the article published in The Electrical World, May 26, p. 712, due acknowledgment was made).

Photometric Units and Quantities.—A translation of the complete article by Mr. Blondel, abstracted in the Digest Aug. 11 (see also Aug. 25 and Sept. 22), is published in the Lond. "Elec.," Sept. 28. It is also discussed at some length editorially, where it is regarded as a most re-

markable contribution to physical nomenclature, but, though a sound system, it is believed that the auther goes rather far. The unit of luminous flux may deserve a name, but it cannot be a candle, as the idea that one candle-power gives a light of $4.\pi$ or 12.57 candles, though technically true, would be too absurd; unless some name is adopted, enterprising lamp makers will advertise lamps of 201 candles, meaning 16 candle-power. The unit "illumination" really needs a name; it is suggested that the three similar units in his table may be reduced to a single unit as their dimensions are identical; this is discussed at some length. As a matter of some interest in connection with dead white reflectors, it is stated that a perfect white reflector of one square foot illuminated with π candle-feet, emits one candle-power normally. The French term "illumination" refers to nothing more or less than the photographer's term "exposure."

Photometer.—The Drossbach photometer is briefly described with the aid of an illustration in "Cosmos," Sept. 22. It consists essentially of two mirrors, each at an angle of 45 degrees, with the two rays from the sources, and with the line of sight. They are also perpendicular to each other, one being in front of the other, the front one having a hole in it through which the light from one source passes to the eye, while the light from the other source is reflected to the eye by means of the front mirror. The two sources are thus compared, the illuminations appearing like in the Lummer-Brodhun photometer, over which it has the advantages that there are no prisms, that it is very much cheaper, and that the rays from the source of light need not be perpendicular to each other.

The Clark Cell when Producing a Current.—A Physical Society paper by Mr. Skinner is, published with illustrations, in the Lond. "Elec.," Sept. 28, and in the "Phil. Mag." for September. He constructed some large cells, and describes experiments made with them, giving the results in a table; he shows that the cell recovered its E. M. F. entirely after having given current, stating that this is a typical instance of the behavior of the cells; a curve of discharge is given. He shows that the E. M. F. of depolarization varies directly with the current density in a particular cell, and that it increases slowly when the current is maintained; he concludes that the small currents of approximately known value can be used with large Clark cells of small internal resistance which may be neglected in comparison with the large external resistance. With a large cell a current of 0.01 ampere could readily be used, corresponding to a density of 0.0001 ampere per square centimeter of zinc. Comparing this with the Board of Trade pattern, he shows that the current taken when connected with a resistance of 10,000 ohms, is very much below that which has been found to be safe in these experiments.

Conductivity Balance.—An instrument made by Messrs. Elliott Bros. is illustrated and described in the Lond. "Elec. Rev.," Sept. 28, and is intended for workshop use for testing large samples with the greatest possible accuracy. It is based on the Thomson bridge, the wires to be measured being placed in series with the standard length. Bars one meter long and three-quarters of an inch in diameter can be tested. A resistance of five millionths of an ohm is easily measured.

Conductivity of Salts.—A paper by Mr. Voellmer, from "Ann. Phys. Chem.," is briefly abstracted in the Lond. "Elec. Eng.," Sept. 28. It treats of salts dissolved in alcohol.

Resistance of Solutions Under Pressure.—The article by Mr. Peisch, abstracted in the Digest Oct. 6, is given in abstract in the "Phil. Mag." for September.

Resistance Box.—A new form by Hartmann & Braun, is illustrated and described in the "Elek. Zeit.," Sept. 27.

Construction of Resistances.—Mr. Morris' article is continued in the Lond. "Elec.," Sept. 28. He describes, with the aid of a number of illustrations, the construction of resistances.

Thermometers of Ethometers.—An editorial in the Lond. "Elec. Rev.," Sept. 28, suggests the use of thermometers as measurements of ether, apparently using the term ether and electricity synonymously. It intimates that we shall most likely arrive at the notion that absolute temperature means absolute molecular contact, free from ether interspersion.

Determining Transition Points.—A paper by Mr. Cohen, from the "Zeit. Phys. Chem." is briefly abstracted in the Lond. "Elec. Eng.," Sept. 28. If a voltaic element be formed by the immersion of similar electrodes in saturated solutions of the two forms of the substances capable of undergoing a transition change, then at temperatures above or below that transition, the current will flow in opposite directions, becoming zero at the transition temperature itself; he uses this method in a number of investigations. It has the advantages of accuracy and speed, but is applicable only to conductors.

Board of Trade Laboratory.—The Lond. "Elec. Eng.," Sept. 28, begins a description of the laboratory and instruments at Whitehall. The laboratory will be controlled by the Board of Trade, and in it will be constructed the Government standards. It will provide facilities for testing commercial instruments. It will include a gas engine and storage battery plant, besides having connection with the city mains for obtaining alternating currents, including those from the Ferranti station for potentials up to 10,000 volts.

DYNAMOS AND MOTORS.

Design of Large Alternators.—Mr. Kennedy, in the Lond. "Elec. Rev.," Sept. 28, refers briefly to the broad principles governing the design, applicable equally to continuous as well as to alternating generators. He divides the latter into three general types—the Siemens, the Gramme and the Lontin. The first type still holds its own, and the four following requirements of a good design are as well met as they can practically be. (1) The flux through the coils rises gradually, the permeability being constant in the armature. (2) The magnetic flux through the field is steady. (3) The magnetic leakage is steady, proved by the non-heating of the poles. (4) There are no laminated cores, reducing the hysteresis and the eddy currents to a minimum. The magnetic leakage is not a minimum but it is quite as great in most other types. The Mordey design is a modification of it, the leakage there being reduced to a minimum. In this form there are no laminated structures, which is a most important point. The Gramme form is next best, but requires a laminated core, introducing hysteresis losses. If the windings lie between teeth or in holes, a variable flux is introduced, but it otherwise fulfils the requirements of a good design. The Lontin type is at present a great favorite. It is now built with a laminated magnet and a laminated armature. There are outward projecting poles carrying the exciting currents, and a concentric massive frame carrying laminated blocks encircled by the armature coils. With such a construction none of the requirements of a good design are obtained. (1) The flux through the coils does not vary gradually. (2) The flux in the field pulsates, setting up hysteresis and eddy current losses. (3) The magnetic leakage is greater than in other designs. The enormous amount of lamination makes it very expensive. The losses increase as the load decreases. When well laminated it may give a higher output than other types, but this is a doubtful advantage.

Graphical Calculation of Dynamos.—A French translation of the article by Mr. Fischer-Hinnen, mentioned in the Digest, Aug. 18, is begun in "L'Eclairage Elec.," Sept. 22.

Brushes.—A German company advertises a new patent brush cased in aluminium, which consists of extremely fine wires woven together, making an almost homogeneous mass. It is stated that 13,000 of these wires will together form a brush of one square centimeter cross-section. A fraying out of the wires is claimed to be impossible. They are guaranteed to last four times as long as any other brushes.

ARC AND INCANDESCENT LIGHTS.

Arc Lamp.—"L'Elec.," Sept. 22, describes a lamp for which claims of great simplicity and cheapness are made. The feeding is done by means of an escapement, like in a clock, the lever being operated by a shunt magnet, whose current is made and broken by the movement of the lever itself. The arc is established by a series magnet. Good illustrations are given.

Projectors.—The article abstracted in the Digest, Oct. 6, is continued in "L'Eclairage Elec.," Sept. 22. It is of a mathematical nature, and discusses the determination of the lighting power of projectors.

Lighting of Interiors.—An article of but little interest, including some comparative estimates for the cost of arc and incandescent light for interiors, is published in "Ind. and Iron," Sept. 7.

Street Lighting.—An article, by Mr. Gay, is published in London "Lighting," Sept. 20.

TRANSMISSION OF POWER.

Di-phase Transmission Plant.—A short description of the plant in the Decize mines, abstracted in the Digest, July 14, is published in "L'Eclairage Elec.," Sept. 22.

ELECTRIC RAILWAYS.

Liverpool Overhead Railway.—The report of the discussion (see Digest last week) is concluded in the Lond. "Elec.," Sept. 28. The first part is devoted to the civil engineering features only. Mr. Moss gives some comparative figures for the Manhattan Elevated Railway, and Mr. Nichols for the Brooklyn Elevated Railway. Traffic on the Liverpool line is about one-seventh that on the Brooklyn, about one-thirtieth of that of the New York line, and about 20 per cent. less than that of the Fifth avenue branch of the Brooklyn line. He stated that the electric conductor and wire were simpler and in every way better than those on the Intramural Railway at Chicago. He believes that if the developments of dynamos and motors continue to improve as they have done during the past four years, no one would think of operating elevated railways of the future by any other medium than electricity. He gives a table illustrating the results obtained as regards station spacing, time and speed for the Liverpool, the Brooklyn, and the two Chicago lines. Another, giving the working expenses of the Liverpool, Manhattan and Brooklyn Elevated Railways. Dr. Preller, of Switzerland, discussed the subject of locomotives vs. motor cars, stating that it is very hazardous to generalize, and that each case must be judged on its merits. He found, for instance, that on steep gradients the train load for 50 passengers by motor cars, electric locomotive and steam locomotive, was 1 to 1½ to 2, but on ordinary gradients the proportion was very different as the number of cars increased. With two or three cars the weight was

about equal. With four cars the electric locomotive possessed a decided advantage over motor cars. It also insured easier and safer manipulation of the trian by one man. He compared the Liverpool motors with those constructed by Messrs. Brown, Boveri & Co., showing that the latter gave, at less weight per unit, considerably more power than those used at Liverpool. Mr. Robinson criticised severely the statement regarding the 88 per cent. efficiency. Captain Sankey called attention to some anomalies in the load curves. In conclusion, Messrs. Parker & Greathead replied to the discussion.

Electric Locomotives in France.—The Lond. "Elec.," Sept. 28, abstracts from the London "Engineer," stating that the Paris-Lyons and Mediterranean Railway is now building 60 electric locomotives, each capable of drawing 800 tons at a speed of 15 miles per hour, and also electric locomotives, "the motor of which is mounted on the rolling stock."

Sectional Contact Rail System at Lyons.—The article abstracted in the Digest last week, is concluded in "L'Elec.," Sept. 22. The distributor is described at some length for the case of a single track over which cars move in both directions. The distributors also form a sort of block system, preventing two cars from getting into the same block controlled by one distributor. The shoes for making contact are illustrated and decribed. They are made of cast iron, and are fixed at the end of permanent magnets so that their magnetic attraction to the contact rail forms the contact, while between these sections a spring raises them off from the pavement. A diagram gives the complete wiring of the car. Over 123,000 passengers were carried on this line during August. A translation of the article abstracted in the Digest last week, is given in abstract, together with some illustrations, in the Lond. "Elec.," Sept. 28.

Lyons-Oullins Railway.—The illustrated description, mentioned in the Digest, Aug. 4, is continued in the Lond. "Elec. Rev.," Sept. 28.

Havre.—An illustrated description of this line, installed by the Thomson-Houston Co., is published in "L'Ind. Elec.," Sept. 25.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Central Station Operation.—The leading editorial in the Lond. "Elec. Rev.," Sept. 28, on the working of central stations, calls attention to a few of the smaller economies in running a central station. It recommends that all stores, including coal, should be kept under lock and key and be obtained only through a formal demand. It advises not to change the men about from one watch to the other and to promote a system of healthy rivalry between the watches; comprehensive report books should be used in each department and each man should be provided with a time sheet; the information should be collected once a week, analyzed and tabulated, showing at a glance what it costs to generate and distribute the current for each week; in small towns the meters should be read once a week.

Ealing.—The Lond. "Elec. Eng.," Sept. 28, publishes at considerable length, with the aid of a number of illustrations, a description of this plant which is about to be inaugurated. It is of special interest, as the source of power will be largely obtained from refuse destructors, and it is said to be the first municipal plant in which this method will be systematically carried out. The population is 27,000, and the plant will have a capacity of 5,000 lamps of 8 cp.; the charge for current will be 12 cts. per kilowatt-hour for lighting and 8 cts. for power; in order to obtain water for condensation the generating station is some distance from the town, and therefore the high tension alternating system will be used.

Zurich.—A description of this installation, including considerable data, is published in the "Elek. Zeit.," Sept. 27.

Nancy.—A small accumulator plant is described and illustrated in 'L'Ind. Elec.,' Sept. 25.

New Form of Lightning Arrester.—In the "Elek. Zeit.," Sept. 27, Dr. Muelleudorff describes a simple form, the object of which is to avoid the trouble caused by the arc, in burning the contact points of the usual lightning arrester; the object is to avoid all sparks and all possibilities of the formation of an arc, and he accomplishes it by an apparatus through which there will be a continuous discharge of atmospheric electricity, while under ordinary circumstances no current will flow. He inserts paraffine paper between two blocks of carbon; when connected with a small influence machine it was found that there was a continuous equalization of the potentials without the formation of sparks, but when connected to electric circuits of the usual voltage, the paper acts as an insulator; the apparatus itself is made of a pile of four or more carbon disks, secured in a closed glass tube and separated from each other by several thicknesses of paraffined paper, connections between the top and bottom carbon being made with the line and the earth respectively; the number of carbons must be proportioned to the voltage of the circuit and their surface to the probable discharge of atmospherical electricity; it has been in use for a year and has proved itself to be very successful; it is applicable also to telegraph and telephone lines.

Regulating Gas Motors.—In "L'Ind. Elec.," Sept. 25, Mr. Wild criticizes the recent paper of Mr. Picou (see Digest, Sept. 8). He differs with that writer in regard to the inefficiency of the flexible spring coupling, giving his reasons; he cites two cases in which the Rafford elastic coupling was used, and in which no perceptible flickering in the light could be noticed, while when that coupling was cut out the flickering was very bad; the oscillations of a volt-meter in one of these was reduced from 4 to ¼ of a volt. He suggests that manufacturers should construct gas engines especially for electric lighting, with a short stroke, a great angular velocity, large bearing surfaces and heavy fly-wheels; the fly-wheel and special bearings might be provided separate from the engine. In a reply by Mr. Picou he states that he came to his conclusions from the failure of such a coupling, and in which he found that the flickering was increased; he discusses the theory and continues to believe that such a coupling increased the evil.

Accumulator Regulator.—The Trumpy apparatus for accumulator regulators, mentioned in these columns several times before, is described and illustrated in "Ind. & Iron," Sept. 14.

Steam Turbine.—An article by Mr. Edgecombe is begun in the Lond. "Elec. Rev.," Sept. 28.

WIRES, WIRING AND CONDUITS.

Earth Charging from Leaking Mains.—A recent Royal Society paper by Messrs. Cardew and Bagnold, is abstracted in the Lond. "Elec.," Sept. 28. From their experiments they conclude that under very different conditions of weather and moisture in the soil, it is possible to produce a fall of potential amounting to 25 per cent. of the whole pressure (600 volts) between points on the ground four feet apart, and that a horse having a resistance of say 400 ohms would therefore receive a severe shock.

Calculation of Leads.—Mr. Loeffler publishes in the "Elec. Zeit.," Sept. 27, a simple and practical graphical method for calculating leads; it appears to be quite simple and is in some respects better than other similar diagrams, but in some other respects not as good.

Bracket with Fuse.—A new form is described and illustrated in "L'Ind. Elec.," Sept. 25.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Protection of Railroad Trains.—In "L'Eclairage Elec.," Sept. 22, Mr. Claude suggests, at some length, the elements of a new system in which there is direct communication between two locomotives in the same block; each has a dynamo connected to the axle with one pole to ground and the other connected through a shunted bell to an insulated wire laid along the track in disconnected sections; when two trains are on the same section both bells will be rung.

Telegraphic Connection with China.—According to the "Elek. Zeit.," Sept., 27, there are at present two lines to China, one through Russia and the other by submarine cable; two other lines are to be constructed, one of them requiring an addiiton of only about 180 miles of wires to present systems, and the other from St. Petersburg direct to Pekin.

Atlantic Telegraphy.—It appears from a note in the Lond. "Elec. Eng.," Sept. 28, that the German government is considering the laying of a cable to America via the Azores.

Telephone in Hungary.—According to the "Elek. Zeit.," Sept. 27, it is proposed to connect all the principal towns of Hungary with each other and the capital by long distance telephone lines.

Theory of, and Minimum Current in Telephone.—The two papers by Lord Rayleigh, abstracted in the Digest, Oct. 6, are published in the "Phil. Mag." for September.

ELECTRO-CHEMISTRY.

Alkali and Bleach.—The Castner process (see Digest last week) is described in the Lond. "Elec.," Sept. 28, the description being about the same as that referred to last week. Exception is taken to the figure given for the electrical efficiency, 88.9 per cent., and from some deductions it is shown that an efficiency of barely 50 per cent. is obtained instead of that which is claimed; the cost of the energy required to produce one ton of caustic soda and about 2½ tons of chloride of lime, would be approximately $21 for a large plant; it is concluded that although a good deal of progress has been made, electrolytic soda and bleach will not yet have the market to themselves.

Electrolytic Soda.—An article giving a general review of the subject by Dr. Rideal is published in London "Lightning," Sept. 27. He states that in his opinion the application of electrolysis to the alkali industry will probably be found in its use for decomposing calcium chloride and not sodium chloride, in which case electricity will aid in the existing process; he bases his opinion mainly on the thermo-electric considerations, as the calcium and magnesium chlorides are more easily decomposed than their equivalents of sodium chlorides.

Bleaching.—According to the Lond. "Elec.," Sept. 28, a system is being tried in Germany in which such substances as starch, dextrine and gum are bleached by ozone generated electrically in a receptacle in which a silent discharge takes place, the gas being blown into the liquids through very fine apertures or else the liquids are sprayed into a chamber filled with ozone. Their market value is said to be greatly increased thereby.

Copper Electrolysis in Vacuum.—According to the Lond. "Elec. Rev.," Sept. 28, Mr. Gannon finds that a heavier deposit was obtained under reduced pressure than under atmospheric pressure; the percentage difference was not constant, but the addition of a little sulphuric acid

made it so; under this condition for current densities above 0.01 ampere per sq. cm of cathode, there is practically no difference in weight between the two deposits, but for lower densities the vacuum deposit is appreciably higher.

Flocculent Electro-depositions.—The Lond. "Elec. Rev.," Sept. 28, abstracts a paper by Messrs. Mylius & Fromm, from the "Elektrochem. Zeit."

Zincing Process.—A brief description of the Cowper-Coles system, containing but little that has not been published before, is given in "Ind. & Iron," Sept. 28.

Purification of Drinking Water.—The "Elektrochem. Zeit.," September, contains a long article by Mr. Oppermann, in which he discusses the subject and describes a process patented by himself; a description of the apparatus is to be published in a subsequent article. In the introduction he states that a current passed through water has no action in destroying the organisms, but in all natural waters there are small quantities of different salts which, by means of the electric current, can be decomposed, and this under certain circumstances, produces ozone and peroxide of hydrogen, both of which have a cleansing action as they destroy the organism by a process of oxidation.

Purification of Dyes.—According to the "Elek. Anz.," Sept. 9, certain dyes contain metallic salts and other materials as impurities, from which it is freed in the Guillot process by electrolysis, in which process the metallic salts are deposited either on the anode as superoxides or on the cathode as metals.

Production of Sulphuric Acid.—It is stated in the Lond. "Elec. Eng.," Sept. 21, that Mr. Hill has invented an electric apparatus for the production of sulphuric acid directly from sulphur dioxide, by means of an electric current of low pressure; the process, however, is not described.

Velvo Battery.—The Lond. "Elec. Rev.," Sept. 28, contains a communication from the inventor, Mr. Barnet (see Digest Oct. 6 and 13), in the form of a reply and an advertisement; he claims that he can get more watt-hours per dollar than a double fluid cell employing nitrate of soda; the available difference of potential while delivering a strong current, is said to be from .5 to .65 per cell; the cost per kilowatt hour of the lighting type of cell may be less than 37 cts.; for chromic solutions these carbons are but little better than plain carbons, but with nitrate of soda they are much better.

Chemical Theory of Accumulators.—Mr. Wade's article is continued at some length in the Lond. "Elec." Sept. 28; he gives a summary of a number of papers which have been published on this subject, and containing therefore nothing new; references to the originals are given, forming a useful collection of references to the best literature on this subject.

Efficiency of Accumulators.—A translation of the article from the French, abstracted in the Digest, Sept. 8, is reprinted in the Lond. "Elec. Rev.," Sept. 28.

Tudor Accumulator.—A brief illustrated description is published in "Ind. & Iron," Sept. 7.

MISCELLANEOUS.

Welding.—"L'Eclairage Elec.," Sept. 22, contains a well illustrated article by Mr. Richards showing a number of machines and giving the power required under different circumstances; it appears to be compiled chiefly through American sources.

Heating Appliances.—A number of these shown at a recent exhibition at Ealing, are illustrated and described in the Lond. "Elec. Eng.," Sept. 28.

Electric Ventilators.—A description containing the illustrations of about a dozen different forms, is published in "La Nature," Sept. 15.

Firing Mines.—An illustrated description of a small hand dynamo of recent design from a French journal, is given in the Lond. "Elec. Rev.," Sept. 28.

Government Inspection in Canada.—An act recently passed for the inspection of meters and the regulation of electric contractors is summarized in the Lond. "Elec. Rev.," Sept. 28.

Electro-therapeutical Apparatus.—An illustrated description of a number of pieces of apparatus is published in the "Elek Echo.," Sept. 29.

Antwerp Exhibition.—The "Bul. Soc. Int.," for July, contains a long illustrated paper descriptive of a visit to this Exhibition; it is the longest and best description which has so far been published.

Educational.—According to the Lond. "Elec.," Sept. 28, the Russian Government has ordered the formation of a military electro-technical school to enable the officers to carry out military electrical work and to investigate electrical discoveries and inventions likely to be of use for military purposes; the course will extend over two years; 70 officers will be instructed at one time.

Biographical.—A biographical notice with portrait of Hermann von Helmholtz by Mr. Guillaume, is published in "L'Ind. Elec.," Sept. 25, and in "La Nature," Sept. 22. "Cosmos," Sept. 29, publishes a biographical sketch by Mr. Dufour; another is given in "L'Elec.," Sept. 22.

Prizes.—A list of the subjects for papers on which premiums will be awarded by the Institute of Civil Engineers of England, are published in the Lond. "Elec. Eng.," Sept. 28.

New Books.

MECHANCAL DRAWING. Projection Drawing, Isometric and Oblique Drawing, Working Drawings. A Condensed Text for Class Room Use. By Walter K. Palmer, M. E. Columbus, O.: Chas. B. Palmer, 50 pages, 6 figures. Price, 80 cents.

This is a very elementary work on the subject, and is the substance of a progressive course taught by the author at the Miller Manual Training School, Crozet, Va. It is intended only as a "teacher's help," and the rules and hints are of a kind to assist in teaching rather than for the direct instruction of the student.

DYNAMO ATTENDANTS AND THEIR DYNAMOS. A practical Book for Practical Men. By Alfred H. Gibbings, A I. E. E., London: Sidney Rentall, 58 pages, 14 illustrations. Price, 50 cents.

The matter contained in these pages first appeared in the columns of London "Electricity," and is intended to offer plain hints and advice to the dynamo tender. The author is electrical engineer to the Corporation of Hull, and therefore presumably well qualified to write on the subject. Considerable information useful to the dynamo tender is given, though much of it is explanatory of apparatus and electrical principles rather than of a direct practical character.

The Association Suisses des Electriciens, which occupies the same place in Switzerland that the American Institute of Electrical Engineers does in America, has issued its *Annuaire* for 1894 under the editorship of its President, Dr. A. Denzler, in the form of a brochure of 140 pages. A paper of 44 pages by the President elect, W. Wyssling, accompanied by ten charts of curves, gives an exhaustive account of the construction and operation of the Zurich central electric lighting station. The information is in great detail, the costs of construction, for example, being itemized under thirty heads, and operating expenses are even more fully detailed. Classified tables give the number of electrical plants in Switzerland, from which we learn that there are 617 isolated plants with an aggregate capacity of 7,180 kw, 77,831 incandescent, and 1,446 arc lamps; and 60 central stations with an aggregate capacity of 6,744 kw, 66,488 incandescent, and 680 arc lamps. A table gives full data in regard to the various central stations, showing, among other things, the relative distribution of current for lighting and power. Lists are given of Swiss patents issued during 1893, and of Swiss government officials having a connection with electrical matters, of the electrical and physical faculty of higher schools and colleges, and of Swiss electrical engineers. There are also tables of government statistical information relating to telephones and the elegraph.

The Engineering Magazine, with its October number introduced a commendable feature, consisting of a "Review of the Industrial Press." The sections in the former department devoted to the different important branches of engineering science, to which have been added several others, are each prefaced by a collection of notes referring to the various articles of value bearing on the subject of the respective sections that have appeared in the technical press since the previous issue of the magazine. The more important articles in each branch are also briefly abstracted, with comments in the editorial section following the notes. As the value of the abstracts will largely, and that of the comments entirely, depend upon the professional competency of the writers in charge of the respective sections, we would suggest that the former practice of placing the names of these at the heads of the sections be revived. If, for example, it were known that the electrical department continued in personal charge of Mr. F. L. Pope, readers of it would have that assurance as to the value of the abstracts and the conscientious character of the opinions expressed, which, if absent, would largely lessen their interest in both.

An Arc-Light Regulator.

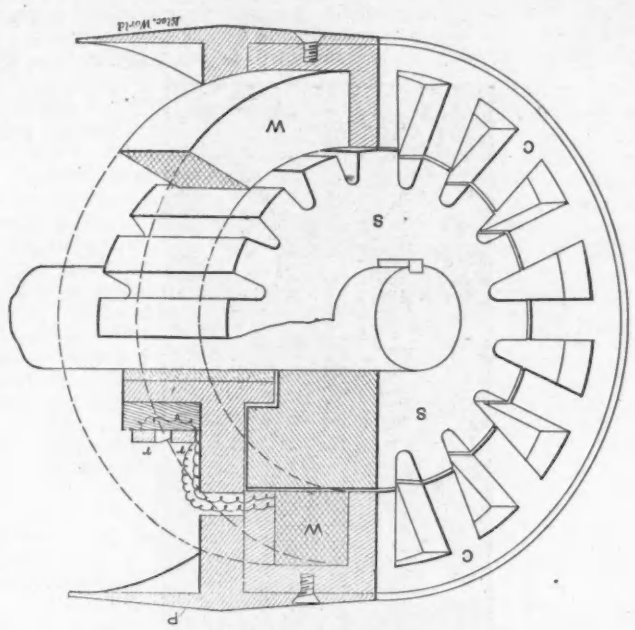
BY F. H. PEMBER.

The automatic regulation of an arc light dynamo has always been a matter attended with considerable difficulty, and necessitating the use of more or less complicated apparatus external to the machine itself. Lately, however, the important effects of self-induction of the armature have been applied as a means of regulation, and, in circuits of many lamps, where counterbalancing effects result in but slight fluctuations of current, will doubtless be a success.

Regulation has hitherto been accomplished by varying one of the three factors of current—number of effective conductors, strength of magnetic field, or speed of revolution. The first factor is the principle involved in the use of the T. H. Wood, and Waterhouse regulators, in which the altered diameter of commutation practically varies the number of effective conductors. The Brush machine is the best example of regulation by changing the strength of the magnetic field. Many pieces of apparatus have been designed to govern the source of motive power, and thereby govern the speed of the dynamo according to the needs of the circuit. Such contrivances must needs be slow in action, and, when more than one machine is connected to a common shaft be entirely inadmissable. The apparatus about to be described is designed to transmit the power to each dynamo shaft in such a manner that no more power will be absorbed than that necessary to keep the required constant current throughout the varying conditions of the external circuit of each particular machine. This is accomplished by means of a magnetic

driving clutch. The apparatus consists of a pulley, P, shown in section in the drawing, which, when the machine is inoperative, runs freely upon the armature shaft. Fitted to the inside of the pulley and fastened to it is a collar, C, supplied with a set of inwardly projecting teeth, similar to an internal gear, but so recessed as to admit the introduction of a coil of wire, W, wound in a rectangular cross section. Firmly keyed to the armature shaft is a "spider," S, having a number of teeth equal to that on the collar, and clearing them by one-hundredth of an inch or so.

Now, when it is desired to set the dynamo in motion, a current of electricity is sent round the coil, gathered from a pair of collecting rings, rr, in which the ends of the coil are terminated. This renders



MAGNETIC CLUTCH.

magnetic the opposed fingers of the collar and spider, and a virtual contact is produced. The pulley, which up to this time has been freely turning upon the shaft, is now bound to it by magnetic attraction, but without actual contact. The strength of this union is proportional to the current in the coil. If now a nice adjustment of this current is effected, the power of the clutch may be so governed that it will carry a certain load and no more.

Now, since the resistance to rotation offered by a revolving armature is due to the "drag" produced by the current flowing in its wires, and proportional to it, any rise of current is attended by a corresponding increment of drag. This increased load is too much for the magnetic bond between the fingers of collar and spider to carry. A diminution of armature speed ensues, which is accompanied by the desired reduction of current.

At no time except when every lamp in the circuit is at its least, that is, when the normal resistance of the circuit is greatest, is the speed of the spider identical with that of the pulley. At all other times the spider lags behind the pulley to an extent determined by the resistance of the circuit, viz.: the number of lamps. This regular falling behind of the spider is, however, by no means identical with the variable slip of a belt.

The instances are rare in which a storage battery would be available as a source of current for the clutch coil; it must, therefore, be made a branch of the main circuit to render the dynamo and regulator self contained.

It will at once be urged that the shunt of the main circuit will vary with it and the magnetic power of the clutch will vary accordingly. This necessitates the use of a simple wall regulator consisting of a solenoid with moving core to which is attached a comb of fine wires of successively changing length which, dipping into a mercury cup, close the circuit of the clutch coil and constitute a variable resistance depending upon the depth of immersion in the mercury. This auxiliary apparatus, though entirely impracticable under the high potential of the main circuit, may readily be used to keep constant the slight current of one or two amperes in the clutch coil.

It is anticipated that further experiment will show that the self-induction of the coil will be sufficient to prevent any fluctuations of the current through it, thus doing away with the wall regulator all together.

Among the advantages of this regulator may be mentioned the cheapness of its construction, minimum liability to derangement, and adaptability to any kind of an arc light machine with but a slight amount of labor. The speed of the armature at any time is maintained at just the right degree, and no power is wasted in useless velocity. Furthermore, if the services of the dynamo are no longer required the armature may come to rest without interfering with the speed of the rest of the shafting.

Protection for Power House Engines.

A patent has recently been issued to Mr. T. C. Coykendall, Chief-Engineer of the Kingston, N. Y., City Railway Company, and of the Cornell Steamboat Company, for a device to prevent the closing of the circuit breaker of a dynamo at a time when the current, which would then flow, would endanger the safety of the dynamo engine. The circuit breaker of the dynamo having broken circuit, nothing is known in the power-house of the condition of the line. If the conditions which caused an overflow or short circuit are still present, and the circuit breaker is closed, the shock caused by the instantaneous load, greater than the maximum for which the engine was designed, is likely to destroy the engine.

To prevent this, and also to secure certain other advantages, a resistance equal to about four times the resistance to which the maximum load is due, is connected in series with the terminals of the circuit breaker. When the circuit has been broken the current still continues to flow over this resistance, and if there is an absolute short circuit on the line, the amount of current so flowing is equal to one-fourth the maximum current which the dynamo is designed to furnish. Thus the amount of current flowing in this resistance is greater, as the line resistance is less.

Suppose that one-half the maximum load may be instantly applied to the engine with safety. This condition is attained when the total resistance of the line is equal to twice that to which the maximum current is due. The combined resistance of the line and the shunt joining the terminals of the circuit breaker is then six times the resistance to which maximum current is due. Therefore we see that when the current flowing over the shunt is equal to one-sixth the maximum current, it will be safe to close the circuit breaker. From this explanation it will be evident that this simple piece of apparatus possesses the following advantages:

First. When the circuit is broken, the current flowing over the shunt prevents the instant unloading of the engine; thus there is no tendency for the engine to run away due to failure of the governor to act promptly;

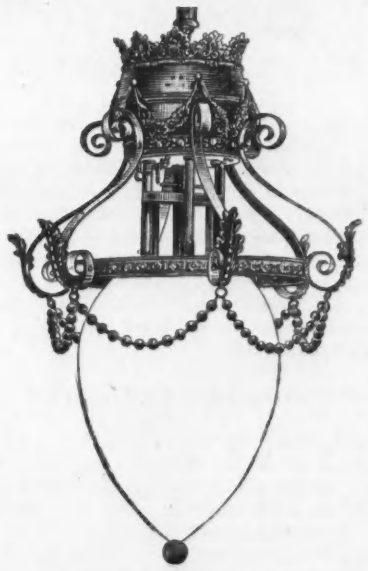
Second. Since the shunt is in series with the station ammeter, by watching the reading of that instrument the attendant knows when it is safe to close the circuit breaker, and thus avoids danger of destroying the engine due to an overload, thrown on instantly;

Third. If a short circuit has been caused by a small wire, that wire is burned off by the current in the shunt, while if circuit breaker is closed it is opened by the overload before the current has time to burn off the wire.

Fourth. By watching the station ammeter the attendant can tell at once when linemen have removed a short circuit. Without this shunt it is necessary for the linemen to go to the nearest telephone, or to send a messenger to the power-house, to notify the attendant that the ground is removed, while with this shunt this is known at once. Thus much time may be saved in the operation of the line.

Imperial Electric Lamp.

The arc lamp we illustrate, manufactured by the Imperial Electric Lamp Co., Postal Telegraph Building, New York, has now been burning in some of the most prominent places in New York for terms varying



IMPERIAL LAMP.

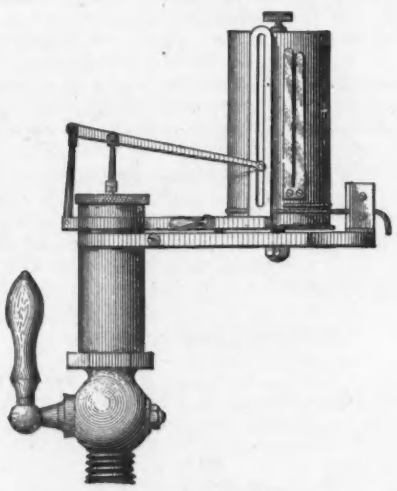
from six to ten months, and it is claimed that, judging from the reports of those who have been using it, the problem of an absolutely steady lamp on an incandescent current has been solved by it. It is also claimed that the principle of the Imperial lamp is entirely different from the others now on the market. The feed is perfectly balanced, and has a positive ratchet-feed movement. A very slight diminution of cur-

rent passing through the carbons (the result of the slightest elongation of the arc), causes the corresponding excess of current to pass through the shunt coil. This coil being thus energized attracts its armature; the circuit, however, is broken by the movement of the armature, and the latter drops back; in this back movement a pawl moves a wheel down one tooth, and the upper carbon is lowered 1-250 of an inch. The feeding is, therefore, so slight each time, that the arc practically does not vary in length at all, with the consequence that the light is absolutely steady. The cut-out embodies also a new principle. Being a chain lamp, the total length is comparatively short for a twelve-hour lamp, being only 26 inches from the top of the lamp to the bottom of the globe, and, for an eight-hour lamp only, 22 inches.

The standard lamp is adjusted to burn two in series, and with a total consumption for both of eight amperes, but they can also be adjusted to burn on any regular direct incandescent current, and to use from 7 to 10 amperes. The company invites the keenest investigation as to the claims of absolute steadiness of light, as well as comparison with other existing lamps.

Valve Setter Indicator.

During the past two years the steam engine indicator has arrived at a state of perfection, beyond which it seems impossible for it to go. While this is unquestionably the result for which every manufacturer is striving, yet there are cases in which this extreme accuracy, attained as it is by such delicacy of construction, serves as a drawback to the use of the instrument. For instance, there is a hesitancy in applying a first-class instrument to a new engine, or one having recently undergone repairs, or changes in the steam piping, on account of the danger of cutting the piston and cylinder by the loosened sand and scale. At such times the question of power is usually not considered and consequently an instrument such as that we illustrate, made by Hine & Robertson, 157 Cortlandt street, New York, will be found to answer the requirements just as well as a better indicator, and can be used with the assurance that if any part is damaged it can be replaced at a merely



Indicator for Valve Setting.

nominal cost. By an examination of the cut its construction can be readily understood. The parallel motion is the well-known slot and the roller device, which is considered sufficiently free from friction to be suitable for an instrument of this class, and it has the advantage of being easily kept in repair. By loosening the small screw shown in the carrying arm, the cock can be screwed in place without rotating the entire instrument, and when in the proper position can be firmly fastened. The drum is very light, and the spring can be adjusted for any speed. As the value-setter is not intended to measure power, the springs are not calebrated, but are stamped with the number of pounds initial pressure they are suitable for.

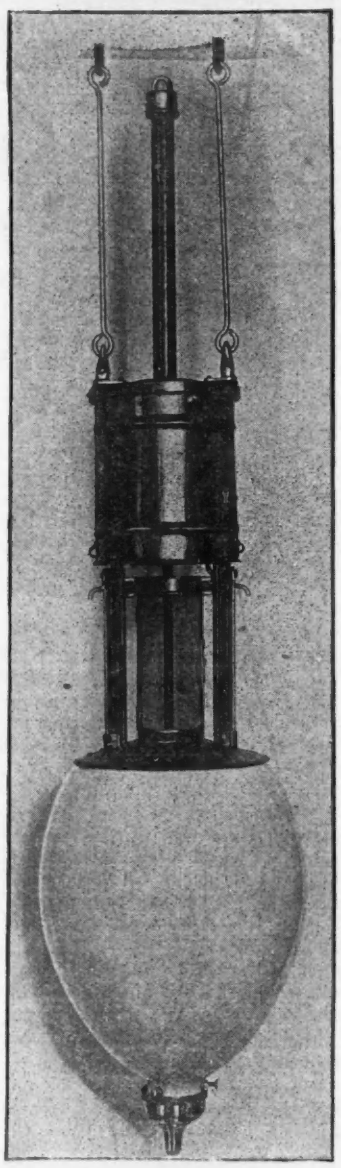
Alternating Current Arc Lamp.

After months of experiment the General Electric Company has finally produced a modification of the '93 Thomson arc lamp adapted to the alternating current, which, it is claimed, places the alternating current for arc lighting on an even footing with the continuous current, whether for indoor or outdoor service.

With the Thomson '93 alternating lamp no external or wasteful resistance is employed; the feeding mechanism is positive, the parts durable and interchangeable, and the regulation perfect. In principle the feeding mechanism is a rack-rod and escapement operated and controlled by an entirely new method. The rack-rod is free to move in both directions without strain on the escapement. The arc is started with none of the "jumping" so noticeably objectionable in the generality of alternating arc lamps. The mechanism is simple in the extreme, and requires no adjustment before installation. All the different styles of lamps, standard, short, focussing, etc., are provided with reflector and spark arrester. The globes may be lowered rapidly and the carbon dust speedily removed.

These alternating arc lamps of a nominal 2,000-cp arc designed for a current of 13 amperes, and are adjusted for that current unless otherwise desired, to be connected in parallel on 32-volt circuits. Each is an absolutely independent unit. The 32 volts can be obtained from the secondary of the transformer, and such transformers wound for 32 volts in the secondary, and of desired capacity will be furnished by the General Electric Company.

It is evident that the great commercial advantages attendant on incandescent lighting by alternating current equally obtain for the alternating arc lamp. If arc lighting alone is to be undertaken the 2,080 or 1,040-volt dynamo feeders run to a central point of distribution; thence the mains carry the current to the transformers, from the secondary of each of which one or more lamps may be operated. In the case of the 2,000-volt primary circuits, there will be but ¼ ampere per lamp,



Thomson Alternating Arc Lamp.

and in the case of the 1,000-volt primaries ½ ampere per lamp. Thus the line losses are reduced to a minimum.

Four hundred and twenty-five watts is the quota of energy for each standard lamp of 13 amperes, and 32 volts in calculating for the transformer capacity to be installed or permissible number of lamps to be run from transformers already installed, but only partially loaded. In the latter case compensator coils may be used for charging the 52 or 104 volts used for incandescent lighting to the 32 volts required for the arc lamp, the change being effected in the compensator coil with practically no loss of power.

With any alternating current arc lamp the exclusive use of cored carbons designed for alternating current lamps is essential. With the standard lamp 9½"x7-16" or ½" cored carbons are used, giving a life of from nine to ten, or eleven to twelve hours respectively. With the short and focussing lamps, if about the same life is required, 7"x9-16" cored carbons are used. American uncored carbons, or even common cored carbons designed for direct currents, cannot be used, and, moreover, their use would prove very expensive, because of the increased potential which they would require over that required for soft carbons when used for alternating current work.

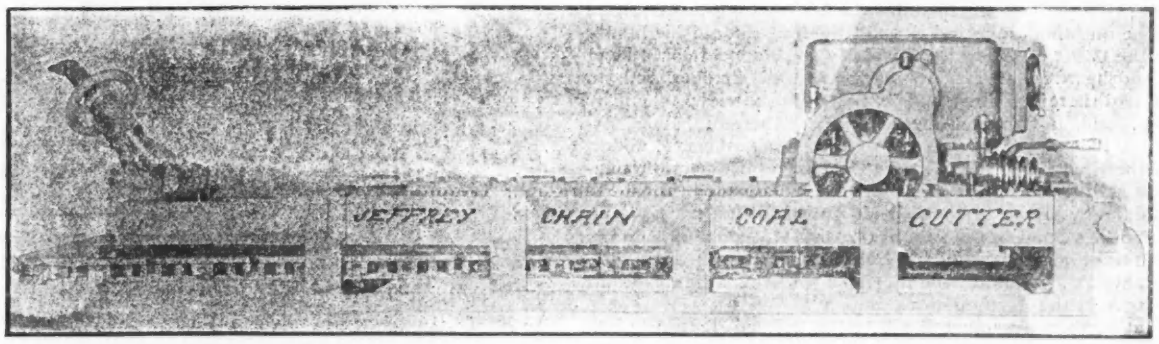
An Electric Coal Cutter.

We illustrate herewith a new coal cutter that has recently been placed upon the market by The Jeffrey Manufacturing Company of Columbus, Ohio. This company, as is well known, has ever since the advent of coal mining machinery, taken a leading place in the manufacture and designing of this class of machinery.

As will be seen from the illustration, this machine is excellently constructed, its strength, lightness and compactness appealing to the qualified observer at once. As will be noticed, the chain on this machine is inside the stationary bed frame, affording the greatest protection to any one that is working around the machine. The chain belt runs in a perfectly fitting guide, which prevents any undue vibration or side motion, which in turn insures freedom from breakages or fouling of the cutters in the stationary parts of the machine. It will also be noticed that this machine has a peculiarity that is not common to other similar machines, the chain belt traveling in a perfectly horizontal plane, so that only the cutters on the front of the cutter head are attacking the coal.

The motor on this machine has been designed especially for mine service. The fields form a perfectly tight and dust-proof case for the working parts of the motor, and access is obtained to the commutator and brushes by raising a lid in the top of the motor casing, this lid in itself being part of the magnetic-circuit and, when the machine is at work, is held down tightly by the magnetism of the field. The switch is also enclosed in an air-tight box so that any spark from the breaking of the circuit will not be able to reach any dust or gas that may be in the vicinity of the machine at the time. The switch itself is so arranged that the man in starting the machine must move it gradually and slowly to the point where the full current is put on the machine. He cannot leave it at any point half way; if he does so, it will immediately fly back and break the circuit. At the end of the cut the man breaks the circuit by pressing a large button, which frees the starting wheel and lets it fly back rapidly, breaking the circuit at once without producing excessive sparking. The armature of this machine is so designed that any coil can be re-placed inside of half an hour at the mine. This is a great advantage to mine operators, as it saves them the necessity of sending the armature back to the factory to be repaired, with the accompanying delays and expense.

It may be stated in passing that with the exception of four or five pounds, all the material used in the construction of this machine is either hammered wrought iron, cast steel or bronze. The use of such material is expensive, but The Jeffrey Manufacturing Company has learned by long and extensive experience that the work that such machinery is called upon to do, requires the very best quality of material that money can buy, and the highest class of workmanship that can be procured. This machine is considerably lighter than the cutter-bar machine, which has met with such great success in the coal mining districts of Ohio and Pennsylvania. The motor will weigh seven hundred pounds less, which will give a good idea of the relative proportions in regard to the weight of the two machines.



AN ELECTRIC COAL CUTTER.

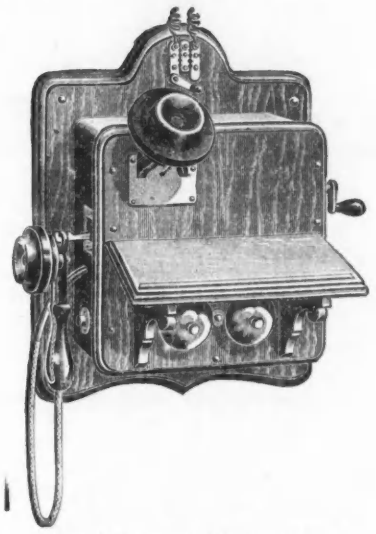
The Phœnix Telephone.

In our issue of last week we referred to a company being organized in New York to give the public a telephone service at $2 per month, and we herewith illustrate the apparatus to be used, which is manufactured by the Phœnix Telephone Company, Produce Exchange, New York.

Both the transmitter and receiver are magneto telephones The former consists of a powerful horse shoe magnet, which is securely bolted, in an inclined position to the back of the wall case in this instance, the ends projecting beyond the cover. In these projecting ends are two soft iron pins, which pass through a soft metal casting upon which the diaphragm rests and to which is secured the mouth piece. In the cavity of the casting and on the extremities of the soft iron pins, are two bobbins of fine wire, the diaphragm fitting against the ends of the pins. The magneto for operating the call bell, which is within the case, is strongly constructed, unusual mechanical solidity and strength being, indeed, the characteristic of all the apparatus. Its power is such that it will ring clearly through 13,000 ohms resistance.

The receiver consists of a metal handle forming the body of the magnet, having a soft metal pin at right angles at one end, on which the bobbin of wire is placed. The handle is recessed for the conductor cord, the latter, therefore, not being in the way; the hard rubber mouth piece and case is neatly and securely fastened to the handle.

When the telephone is not in use, the receiver hangs on a hook which, in that position, completes the calling circuit, and when taken off the hook, the speaking circuit is switched in. A button to the left



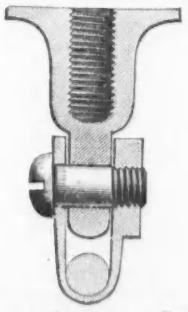
THE PHOENIX TELEPHONE.

of the case switches in the calling circuit when the receiver is at the ear, thus not requiring the hook to be manipulated.

The telephones, magneto and all details, seem to have been designed with more than ordinary care and intelligence, and have a practical appearance that bears out the claim that they are really intended for duty, and which recent tests have demonstrated to be the case. Within the last ten days, we are informed, the most satisfactory results were obtained in talking through 75 miles of ordinary telephone wire, using a ground return. One of the strong points of the telephones is their exceedinly clear and accurate enunciaiton, and the volume of sound is claimed to be not inferior to that of battery telephones.

A New Trolley Sling.

The accompanying cuts show an elevation and sectional view of the Jewell trolley sling, which the Ohio Brass Company, of Mansfield, O.

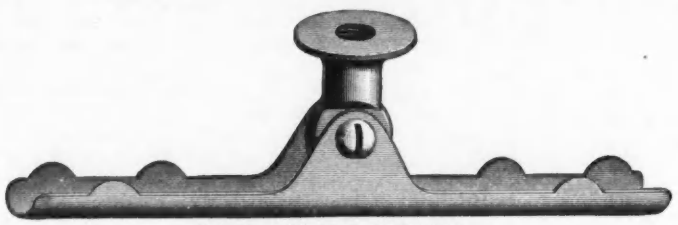


JEWELL TROLLEY SLING.

has recently made arrangements to manufacture. This ear is especially adapted for trolley suspension on straight line work, where a flexible

support is desired, as is the case particularly where the ordinary pole bra ket construction is used.

The lug into which the hanger stud is threaded is swiveled in the body of the ear, so as to admit of an oscillatory motion when the trolley wheel passes under it. This overcomes to a large extent the pounding effect of the trolley wheel on the insulator. In attaching to the trolley wire the swivel bolt is first unscrewed, and the lug removed. The wire



Jewell Trolley Sling.

is then dropped into the groove and the lips bent over it, securely holding it in place. The lug and bolt are then replaced, and the ear fastened on the hanger body. As no soldering or special tools are required, this operation is a quick one, and the result is a strong, flexible support for the trolley wire, which will cause no arc when the trolley wheel passes under. The standard length of the ear is 9 inches. It is made of a composition brass metal, which is best adapted for this class of work.

Judge Lacombe's Storage Battery Decision.

A communication received as we go to press gives a clear statement from the standpoint of the Electric Storage Battery Company regarding the questions involved in the recent decision of Judge Lacombe—an abstract of whose opinion in the case appears in another column in this issue.

The Electric Storage Battery Company, by its president, W. W. Gibbs, says, in this statement, that it has not been enjoined from either manufacturing, selling or using the chloride accumulator, nor has any one been enjoined from purchasing or using chloride cells. The decision of Judge Lacombe merely enjoins the Edison Electric Illuminating Company of New York, from installing chloride accumulators as a part of its central station plant pending the hearing and determination of the question at issue in a suit pending in the Circuit Court of Appeals, upon the grounds that the Edison Company, having simply contracted for the accumulators and not having yet actually installed them, might not be permitted to do so until the questions involved in the litigation should be finally determined in the Court of Appeals, especially as an appeal could be at once taken to and heard in that court on the 30th of October, and an early decision had therein This, it is claimed, is the view taken by Judge Lacombe, and upon which he acted; and, therefore, Judge Lacombe's decision, it is added, has no other effect or significance, and in no way affects the Electric Storage Battery Company's business of manufacturing and selling accumulators, and was conditioned upon the Accumulator Company giving to the Edison Electric Illuminating Company of New York, a bond in the sum of $20,000, to make good any loss which it might sustain resulting from the delay in installing the chloride accumulators, should the decision of the Circuit Court of Appeals be against the Accumulator Company.

The statement further says that the Electric Storage Battery Company has been advised by its counsel and experts, among whom are Profs. Chandler, Barker, Houston and Kennelly, that the chloride accumulator is not an infringement of any patent owned by either the Accumulator Company or the Consolidated Electric Storage Battery Company, and that in their opinion the Swan patent is invalid and expired with the Swan Danish patent in 1888, and that this defense was not passed upon, through Judge Lacombe holding that on the motion for preliminary injunction Judge Coxe's decision was controlling and must prevail until the consideration of the case in the Circuit Court of Appeals, when this defense will be fully heard for the first time, as in the case wherein Judge Coxe sustained the Swan patent no appeal was taken.

The facts of the case are stated to be, that in December, 1890, the Accumulator Company brought suit in the United States District Court of New Jersey, and down to the fall of 1893 no attempt was made by it to press the case, and it was finally abandoned. The Swan patent at that time was owned by the Accumulator Company, although they did not include it in that suit, or after abandoning the latter make any claims against the chloride plate, until last August, when the Edison Electric Illumnating Company selected the storage battery for its central station. Then, instead of bringing suit against the Electric Storage Battery Company, application for a preliminary injunction was made against the Edison Company.

The statement concludes with the assertion that the manufacturing of the chloride accumulator will be continued and batteries furnished under an absolute guarantee, and that the company will at all times sustain its position against threatening companies which proceed against its customers but not against the Electric Storage Battery Company itself.

Reference is made to the decision of the New Jersey Court in last January, denying the motion for any injunction made by the Accumulator Company, since which date the suit has been entirely dismissed.

The Imperial Telephone.

The telephone illustrated herewith is in appearance very much like the ordinary Bell telephone, the most noticeable difference being in the transmitter.

The pattern shown in Fig. 1 is for exchange or private use. Fig. 2 illustrates the Imperial telephone switch hook, which is claimed to be free from the Bell telephone switch patents. The device, as will be seen, is compact and simple. When not in use it locks the telephone, thus avoiding any possible chance for it or the cord to become disarranged. Fig. 3 illustrates a multiple telephone cut-out, which obviates trouble from the instruments being burned out by crosses or by lightning.

Another improved feature of this telephone, which is made by The

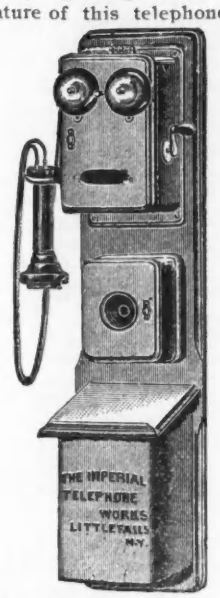


Fig. 1. Imperial Telephone.

Imperial Telephone Works, of Little Falls, N. Y., is the receiver, which has a pneumatic attachment, consisting of an inflated air cushion. This increases the hearing, for the reason that, being yielding, when placed

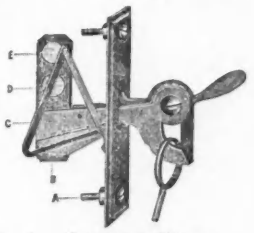


Fig. 2. Switch Hook.

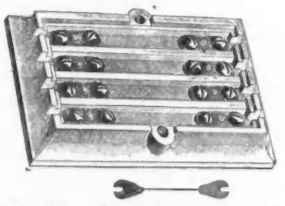


Fig. 3. Multiple Cut-Out.

to the ear it conforms to its shape, concentrates the sound so that none can escape from the receiver, and also excludes all exterior sounds.

Poland Dynamo Brush.

So small a thing as a dynamo brush is, after all, one of the most important factors in the success of electrical generators and motors, and for this reason much time and money have been expended in devising different types of brushes.

A very interesting one is herewith illustrated, known as the Poland brush, and manufactured by Lawrence Poland, of 130 South Second street, Cincinnati. It consists of a bundle of copper wire held in form

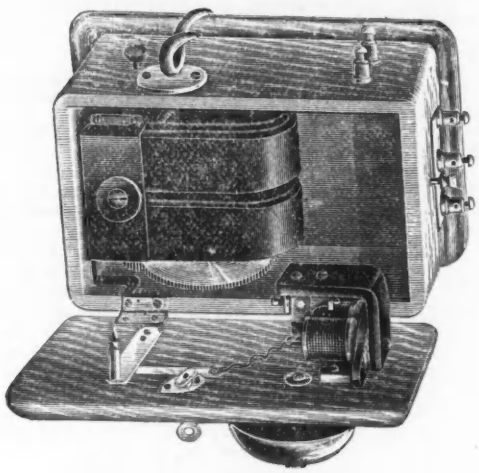
Dynamo Brush.

by a covering of copper wire gauze. This covering is secured by a copper thread cross-stitched through the center of the brush. In this manner each strand is held firmly to the surface of the commutator, and an efficient contact secured. The large number of contacts allow these brushes to carry, without sparking, a current three times as large as the safe limit of a sheet copper brush of the same size. The minute subdivision of the brush also gives the requisite spring without stiffness, and obviates the disagreeable singing noise always produced by sheet copper brushes.

Magneto Signal Bell.

This magneto signal bell we illustrate, is wired for and equipped with a semi-automatic telephone switch, which is claimed to be entirely free from infringement of the patents of the Bell Telephone Company.

The operation of switch is very simple; when the receiver is removed from hook, the button on door of the bell, if pressed, will lock in a spring and stay so until the receiver is replaced on hook, when it automatically returns to its normal position. The contact on the hinges of



TELEPHONE MAGNETO BELL.

the door is kept in good electrical condition by a rubbing action when the door is swung open and shut. The adjustment of gongs is simple, and not liable to become changed through carelessness, as it is only necessary to loosen the screw that holds the standard the gong rests on, when the gong can be adjusted merely by turning. This bell is one of the many telephone specialties of the Manhattan Electrical Supply Company, 32 Cortlandt Street, New York.

General Electric at the Atlanta Convention.

The exhibit of the General Electric Company at the Atlanta Convention will be of an elaborate nature, comprising motors, controllers, other car equipment parts, station switchboard panels, line material, watt-meters, etc.

The G. E.-800 motors will be shown not only in the exhibit proper, but, mounted on cars, will operate over the lines of the Atlanta Street Railway Company. Ample opportunity will be afforded for a close and critical examination of these motors and of the component parts which enter into their construction. The motors, shown in operation, will act in conjunction with the "*K*" controller, and those interested will be enabled to investigate the merits of the combination. The principle of the magnetic blowout device will also be shown and explained and its action demonstrated. This principle is embodied in all other devices in which electric arcs may occur, such as switches, fuses, lightning arresters, etc.

Several sizes of generator and feeder panels for station switchboards, all of black marbleized slate with the necessary instruments mounted thereon, will also be shown. These panel boards are made in various capacities to suit the requirements of the plant, and have been devised so that the switch boards may be increased in size as the station grows merely by the addition of other panels. The line material exhibited will embody several improvements of an important character, which have become necessary by the increased demands of railroad service.

The Thomson recording watt-meter in its portable form for testing on moving cars will also form an important item of the exhibit, which will be illuminated by means of Thomson '93 arc lamps for railway circuits, connected in series and operating on the railway lines. They have been especially designed for use in power-houses car-barns and elsewhere, where light is desired from the 500-volt circuit.

The exhibit will also comprise samples of underground feeder tubing with models of junction boxes and taps, and amongst the literature which will be distributed will be found a special pamphlet dealing with the application of the three-wire system to street railway work.

The interests of the General Electric Company will be in charge of Mr. W. J. Clark, General Manager of the Railway Department. He will be ably assisted by Messrs. W. H. Knight, Chief Engineer of the Railway Department, Theo. P. Bailey, H. H. Corson, H. J. Crowley, W. B. Potter, H. C. Wirt and A. K. Baylor.

Exhibitors at the Atlanta Convention.

The following is an official list, furnished by the Secretary of the American Street Railway Association, of those who have been assigned space in Machinery Hall, in which to display their exhibits at the Street Railway Convention to be held in Atlanta, October 17, 18 and 19, 1894.

Many other manufacturers and dealers in street railway supplies will have exhibits in the spaces of firms enumerated in this list. Judging by the interest displayed by the street railway equipment and supply men, it is probable that the number of exhibits at the forthcoming convention will be larger than at any previous meeting of the Association.

THE STIRLING CO., Chicago, represented by Thomas Deegan.

THE JOHN STEPHENSON CO., N. Y., John A. Thackaberry and D. W. Pugh.

THE FIBERITE CO., Mechanicsville, N. Y., H. J. Medbery.

THE SIEMENS & HALSKE CO., Chicago, A. W. Wright.

THE STANDARD RAILWAY SUPPLY CO., Chicago.

J. E. LOUGHRIDGE, Phila., Pa.

THE STERLING SUPPLY & MANUFACTURING CO., N. Y. Mr. Carson.

THE CUTTER ELECTRICAL & MANUFACTURING CO., Phila., Pa., W. E. Harrington, C. E. Bibber.

THE NEW HAVEN CAR REGISTER CO., New Haven, Conn.

E. F. DE WITT & CO., Lansingburgh, N. Y.

THE JACKSON & SHARPE CO., Wilmington, Del.

THE CENTRAL ELECTRIC HEATING CO., N. Y., E. B. Wyman.

THE BALTIMORE CAR WHEEL CO., Baltimore, Md., J. P. Baker.

THE KELLER PRINTING CO., J. F. Bushe.

THE FITZGERALD-VAN DORN CO., W. T., Lincoln, Neq., Van Dorn.

THE DANIELS STEEL RAILROAD TIE CO., Youngstown, O., T. Burton.

THE LEWIS & FOWLER MFG. CO., Brooklyn, N. Y., L. E. Robert, S. A. Morrell, George Whipp.

THE J. G. BRILL CO., Phila.

THE McGUIRE MANUFACTURING CO., Chicago, Ill., W. A. McGuire, W. J. Cooke.

THE INDUSTRIAL MUTUAL INSURANCE CO., Boston, Mass., Mr. Taft.

THE BASS FOUNDRY & MACHINE WORKS, Ft. Wayne, Ind., P. F. Leach.

THE HARTFORD WOVEN WIRE MATTRESS CO., Hartford, Conn., H. E. Evans, C. G. Smith, N. Y., Thos. C. Millen.

THE MATHER ELECTRIC CO., Manchester, Conn., T. C. Perkins.

THE GENERAL ELECTRIC CO.

THE FULTON TRUCK & FOUNDRY CO., Cleveland, O., W. E. Haycox, Frank A. Rogers.

THE DAVIS CAR SHADE CO., Portland, Me., C. M. Fuller, Geo. F. Card, Reid Carpenter.

THE PAIGE IRON WORKS, Chicago, E. S. Nethercut, A. W. Paige.

THE CONSOLIDATED CAR HEATING CO., Albany, N. Y., N. H. Ranson, J. F. McElroy.

THE R. A. CRAWFORD MANUFACTURING CO., Pittsburg, Pa., R. A. Crawford, C. N. Wood, C. J. Mayer.

THE WADHAMS OIL & GREASE CO., Milwaukee, Wis., E. A. Wadhams, G. A. Streeter.

THE PECKHAM MOTOR TRUCK WHEEL CO., N. Y., E. Peckham.

THE OHIO BRASS CO., Mansfield, O., C. K. King.

THE GRAHAM EQUIPMENT CO., Boston, Mass., J. H. Graham, G. S. A. Gardiner, C. O. Lenz.

THE CREAGHEAD ENG. CO., Cincinnati, O., T. J. Creaghead, G. R. Scrugham.

THE MICHIGAN ELECTRIC CO., Detroit, Mich., J. E. Lockwood.

THE ROCHESTER CAR WHEEL WORKS, Rochester, N. Y., F. D. Russell, G. C. Morse.

THE INTERNATIONAL REGISTER CO., Chicago, A. H. Englund.

THE R. D. NUTTALL CO., Allegheny, Pa., F. A. Estep.

THE GENETT AIR-BRAKE CO., Chicago, Ill., E. J. Wessels, G. S. Lee, Samuel P. Ferree.

THE WALKER MANUFACTURING CO., Cleveland, O., F. Billings, W. H. Bone, S. H. Short, H. McL. Harding, Ed. Kohler, J. M. Atkinson, B. M. Barr, H. A. Darrall.

THE BREESE & MANSFIELD CO., Philadelphia, Pa.

THE H. W. JOHNS MANUFACTURING CO., N. Y., W. F. D. L. Crane, H. G. Issertel, J. W. Perry, E. B. Hatch, H. Luscomb.

WESTINGHOUSE ELECTRICAL & MANUFACTURING CO., Pittsburg, Pa.

CLAUDE ESTES, Esq., Macon, Ga.

NATIONAL LOCK WASHER CO., Newark, N. J.

AMERICAN RAILWAY MAINTENANCE SYNDICATE, New York.

CHARES L. CORNELL, Hamilton, O.

T. J. THOMAS, Knoxville, Tenn.

JAMES W. NAGLE, "The Car," Philadelphia, Pa.

STILWELL-BIERCE & SMITH-VAILE CO., New York.

YOUNG LOCK NUT CO., New York.

A. HAAS & R. E. WATSON, Atlanta Ga.

Financial Intelligence.

The Electrical Stock Market.

New York, Oct. 12, 1894.

DETROIT ELECTRICAL WORKS stock is about to emerge from its long spell of inactivity. A meeting of stockholders is to be held in Detroit on the 15th inst. to determine on a plan of reorganization and some dealings may be had in the present stock to settle its value.

BELL TELEPHONE stock is down this week on revived reports of new competition. Mayor Schieren of Brooklyn has approved the bond of the New York and Eastern Telegraph and Telephone Company for $50,000, and it is feared that this concern may develop considerable opposition in the profitable metropolitan district.

ERIE TELEPHONE has been the feature of the Boston market. New York houses like T. W. Myers & Co., and others prominent in "arbitrage" business, being prominent buyers of the stock. It is intended to list Erie Telephone on the New York Stock Exchange, and quite a business will then be done in the stock in the two markets. The company owns a controlling interest in three telephone corporations, and has paid 4 per cent. annual dividends for years, though its present earnings are at the rate of 6 per cent. per annum.

THE ELECTRICAL STOCKS, by reason of the prominent part "Industrials" continue to play in the stock market, still contribute a good deal to whatever activity is noted these days in Wall street. With all conditions warranting bullish sentiment, trading, however, continues mainly on the bear tack, and therefore, has no real significance when quotations fail to reflect the statements repeatedly made in these columns of reviving trade. The dividend payments continually reported and herein noted tell a story quite contrary to any falling quotation that the appended table may record.

EDISON ILLUMINATING (New York) stock was barely affected by the injunction granted this week preventing it from using the batteries made by the Electric Storage Battery Company, though the stock of the latter company fell in Philadelphia from 33 to 23 on the news of the injunction, though it afterwards again rose to 30. The Edison people are not much disturbed over the matter. The patent in question expires next May, and the batteries will be used in the meantime under bond until the litigation is settled. Treasurer Joseph Williams reports earnings for September as follows: Gross, $101,030; increase, $14,099; net, $48,606, increase, $4,411. For the nine months ending September 30, the company reports: Gross earnings, $967,389; increase, $115,169; net earnings, $502,964; increase, $118,094. This is very flattering in view of general business conditions.

WESTINGHOUSE ELECTRIC, preferred and common stocks are a little higher. The feeling on these shares is more bullish than ever. At the present rate of business the company is making a tremendous profit on the capital invested. If it is making so much money now, there is no calculating how large profits it will earn when it moves into the new works, whose capacity is much above that of the present factories, while the arrangement of the plant is such that it will result in a saving on the cost of manufacture of from 20 per cent. to 25 per cent. At present the old factories are working up to their fullest capacity, and many orders are being taken subject to delay. The Westinghouse people claim that they are now doing a gross annual business nearly equal to that done by the General Electric Company, and assert just as confidently that their margin of profit is much greater. One-third of the present manufacturing business of the Westinghouse Company is in the lighting department; the new incandescent stopper lamp is meeting with continued favor in every quarter and its introduction has proved a most gratifying success. The prices obtained in all new business are right up to schedule figures. In view of these official statements, it is not to be wondered at that the investment demand for Westinghouse issues continues unabated.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked
Brush Ill., New York	50	10	30
Cleveland General Electric	100	80	90
Detroit Electrical Works	10	3	4
East River Electric Light Co.	100	—	50
Edison Electric Ill., New York	100	102	102¼
" " " Brooklyn	100	102⅝	103
" " " Boston	100	120	121
" " " Chicago	100	135	145
" " " Philadelphia	100	122	124
Edison Electric Light of Europe	100	1	3
Edison Ore Milling	100	10	15
Electric Construction & Supply Co., com.	15	7⅛	10
" " " " pref.	15	7½	10
Fort Wayne Electric	100	2¼	2¾
General Electric	100	37½	38
General Electric pref	100	70	72
Interior Conduit & Ins. Co.	100	25	35
Mount Morris Electric	100	25	50
Westinghouse Consolidated, com.	50	35½	36
* " " pref	50	52	53

BONDS.

*Edison Electric Ill., New York	1,000	107⅝	108
Edison Electric Light of Europe	194	75	85
General Electric Co., deb. 5's	1,000	94	95

TELEGRAPH AND TELEPHONE.

*American Bell Telephone	100	199½	200
American District Telegraph	100	40	45
American Telegraph & Cable	100	90½	91
*Central & South American Telegraph	100	105	110
*Commercial Cables	100	125	145
Erie Telephone	100	55½	56
Gold & Stock Telegraph	100	102	105
*Mexican Telegraph	100	180	190
New England Telephone	100	67	69
Postal Telegraph-Cable	100	50	60
*Western Union Telegraph	100	87½	88

* Ex-div.

THE WESTERN UNION TELEGRAPH COMPANY made public this week the annual report for the year ending June 30, 1894. After paying dividends there is a surplus of but $120,815, as compared with a surplus in 1893 of $1,930,841, in 1892 of $2,158,386, and in 1891 of $1,364,758. The balance sheet shows the possession of real estate worth $4,979,533 and stocks and bonds worth $7,296,679. There was an increase in the bonded debt of $25,311. As compared with 1893 there was a reduction in gross revenue of $3,125,787, a saving in expenses of $1,422,235 and a loss in net profits of $1,703,733. Dividends, however, were not reduced. The stock closes for the week at a trifling loss due to this showing.

GENERAL ELECTRIC has declined somewhat this week, yet its prospects are no less bright than they were a week ago. There is, notwithstanding, sentiment in Wall street, and, when that sentiment is disposed to be bearish, prospects and developments, no matter how favorable, count for naught. Very little trading has been done in the stock. What has been done has been for the bear account and has hardly served to more than increase an already unwieldy short interest. This, at present, is the biggest bull factor on the stock, for, should the bear clique be once scared, it will not take much buying to make them tumble over one another to cover short contracts. One obstacle to a big advance lies in the large amount of floating stock. If two or three large owners of the common stock could be induced to lock up their holdings for a year, the available supply would be greatly reduced, and a little buying would cause large advances. Of course, this would after a while restrict trading, but prices would then be on a higher level, and speculation would be based on a more profitable basis. Reports of new business continue in the same cheerful strain. There has sprung up within the last few weeks a tremendous boom in new electric street railway enterprises, and the General Electric Company is making strenuous and often successful efforts to secure its due share of the profitable contracts for equipping these new roads and on a cash basis. The days of taking stocks and bonds in new companies for payment of apparatus are happily gone.

New Incorporations.

THE NOWOTNY ELECTRIC COMPANY, Cincinnati, Ohio, capital stock $25,000, has been formed to manufacture and deal in electrical goods and supplies. L. R. Keck, John S. Nowotny, A. G. Corre, Claude Ashbrook, and H. D. Emerson.

THE KEYSTONE ELECTRIC STREET RAILWAY COMPANY, Philadelphia, Pa., capital stock $180,000, has been formed to construct and operate an electric street railway. Thos. W. South, Chas. P. Tomlinson, Philadelphia, and Frank F. Bell, Bristol, Pa., are interested.

THE HESTONVILLE & OVERBROOK PASSENGER RAILWAY COMPANY, Philadelphia, Pa., capital stock $5,000, has been incorporated to construct, maintain and operate an electric railway. John Hopkins, Isaac Blum and Simon J. Martin, of Philadelphia, are the promoters.

THE THOMPSON-BROWN ELECTRIC COMPANY, New York, capital stock $25,000, has been formed to deal in all kinds of electrical machinery, apparatus, etc. George Thompson, Oyster Bay, L. I.; M. W. Brown, Hyde Park, Mass.; and Ernest F. Ayrault, New York, are the promoters.

THE FARADAY ELECTRIC AND CHEMICAL COMPANY, Kittery, Me., capital stock $150,000, has been incorporated to manufacture and deal in electrical and chemical machinery. W. W. Jacques, Newton; Belle L. Ruggles, Reading; and James H. Flanagan, Boston, Mass., are interested.

PHILADELPHIA & NESHAMINY ELECTRIC RAILWAY COMPANY, Philadelphia, capital stock $75,000, has been formed to construct, maintain and operate an electric railway. The incorporators are Thos. W. South, Tacony; Chas. P. Tomlinson, Bustleton, Philadelphia, Pa., and Frank F. Bell, Bristol, Pa.

THE INTERSTATE FUEL, LIGHT & POWER COMPANY, Chicago, Ill., capital stock $6,000,000, has been incorporated to manufacture and sell gas and fuel, light and power, and materials, machinery and appliances therefor, and for the distribution of the same, etc. J. W. Keneval, J. I. McCauley, Charles Rose, Otto Schanzenbach and Jesse A. Baldwin are the promoters.

Special Correspondence.

New York Notes.

Office of The Electrical World,
253 Broadway, New York, Oct. 12, 1894.

H. WARD LEONARD has removed his offices from 136 Liberty street to the Edison Building, 44 Broad street.

THE RAPID TRANSIT COMISSIONERS, at their meeting on October 10, received an exhaustive report from its chief engineer, W. B. Parsons, on the underground transit systems of European cities, to which he had devoted a summer of study and investigation. In regard to motive power, the conclusions of the report are that an underground railway operated by steam, even with the most approved system of mechanical ventilation, would be intolerable to the people of the city of New York, and that a railway with a speedy, frequent service can be operated successfully and economically by electricity.

Canadian Notes.

Ottawa, Oct. 8, 1894.

GALT, ONT.—The directors of the Galt and Preston Electric Street Railway are applying to the Legislature for power to increase the capital stock from $50,000 to $100,000; also to apply for Letters Patent, extending its powers to the construction and operation of a line of street railway from Preston through the Township of Waterloo to Hespeler.

TORONTO.—The Board of Works has given the Georgian Bay Aqueduct Company the right to lay mains on the streets of the city to supply electric heat, light and power; the only condition attached is that the maximum charge for electricity in any form shall be one cent per horse power per hour.

It is likely a provision will be inserted in the charter requiring 5 per cent. of the gross earnings to be given to the city.

OTTAWA, ONT.—There has been some talk about running the Canadian Pacific Railway trains in the West by electric power, got from the water shores in the Rocky Mountains. Asked as to what the real condition of affairs is, Sir William Van Horne said: "Yes, that has been suggested. There is no doubt that it could be done and done well. The only question of any importance is this: Can we put out the necessary capital for the works and expect the proper return by way of interest? We are considering that question, rather each director for himself than as a Board. For myself I don't mind saying at once that I don't see that the scheme is financially a practicable one. Certainly not at present."

HULL, QUE.—Hull is to have an electric street railway and an electric light system. An offer was made at the Hull council meeting last evening, considered, and before midnight adopted. It is a joint stock company that will engage in the undertaking, of which T. Viau is the leading spirit. The company will bind itself to begin the construction of an electric line that will give satisfactory service to Hull and connect Hull with Gatineau Point, Ironsides and Aylmer within three years. It will have thirty years franchise, during which time the city shall not grant similar power to any other company. The company agree to expend $15,000 the first year and at least $5,000 each year following until the line is completed.

ENGLISH NOTES.

(From our own Correspondent.)

LONDON, October 4, 1894.

THE BRUSH COMPANY.—The results of the year's work of the Brush Electrical Engineering Company is an improvement upon that of the Electric Construction Company to which I recently referred. Notwithstanding what must be termed its inflated capital of £575,000, the Brush Company has succeeded in paying, for the year ending June 30, a 5 per cent. dividend on its ordinary shares, notwithstanding that in front of these shares there are 90,000 £2 6 per cent. preference shares, and 125,000 of 4½ per cent. debenture stock. The Company, however, still appears to receive a large portion of its income in shares of subsidiary companies; a mode of procedure, which, if persisted in, will certainly result in reduced dividends.

ELECTRIC METERS.—It is always considered in this country an unprofitable proceeding to have the accuracy of one's gas meter tested, since the invariable result is that it is certified to register several per cent. *too low*, and therefore the net result is that the suspicious customer has to pay the cost of the test, and to receive from the gas company a meter which does not kindly undertake the task of keeping down his gas bill. Electric meters are apparently following in the same path. In the report recently published by the surveyor of the Chelsea Vestry he states that only one application was made to that authority to test a customer's electric meter, with the result that it was found to register 8¼ per cent. too low. The electrical company, on receiving this information promptly supplied the dissatisfied customer with a more accurate recorder of his consumption.

News of the Week.

TELEGRAPH AND TELEPHONE.

UHRICHSVILLE, O.—Geo. T. Fleming, of Dennison, has receievd a franchise to complete a telephone system.

BROOKLYN, N. Y.—The bonds of the New York and Eastern Telegraph & Telephone Co., which recently got a franchise from the Brooklyn Aldermen, have been approved and it will begin work at once.

ALBANY, N. Y.—The Standard Telegraph & Telephone Company has been incorporated with a capital stock of $50,000. The directors are James H. Mills, Asa C. Bissell, Chas. J. Gidden and Abnor S. Adams, of Lowell, Mass.; Arthur L. Andrews and A. Page Smith of Albany, and others

LITTLE FALLS, N. Y.—The work of constructing the new line of the Inter-State Telephone Co., of which Victor Adams is president, is about to begin. Leroy T. Carver, of this place, has the contract. The line will extend from Little Falls to Canajoharie, connecting the towns with St. Johnsville and Fort Plain.

ELECTRIC LIGHT AND POWER.

NORWICH, CONN.—The city is agitating the question of erecting an electric light plant.

AMERICUS, GA.—The city is considering the erection of an electric light plant. Address the Mayor.

FREDERICKSBURG, VA.—A committee is obtaining estimates on the cost of an electric light plant for the city. Address the Mayor.

NEOSHO, MO.—The Neosho Electric Light Company will erect a plant if the city grants a franchise. The machinery is all contracted for.

PENSACOLA, FLA.—The Pensacola Electric Light & Power Company has added a 650-light alternator, purchased from the General Electric Company.

PALATKA, FLA.—The Palatka Electric Light, Power & Supply Company has closed with the General Electric Company for two 25-kw direct current dynamos.

ST. LOUIS, MO.—The St. Louis Underground Service Company has submitted to the B. P. W. supplemental plans for conduit connections in several streets.

NEW ORLEANS, LA.—The Louisiana Electric Light Company, at a meeting to be held in New York shortly, will consider the erection of a power-station for electric car service.

PENSACOLA, FLA.—It is said that Mr. E. A. Sweet, present superintendent of the Pensacola Electric Light Company has leased the plant for a term of years and that it will be put in first-class shape at an early date.

SEATTLE, WASH.—The Diamond Ice & Storage Company has filed its acceptance of the 25-year franchise to lay pipes, wires and conduits for distributing steam, hot water, gas and electricity for heat, light and motive power.

BUFFALO, N. Y.—A building is to be erected at the S. W. corner of Elliott and Carroll streets by Wells, Williamson & Company, which will use electric power from Niagara Falls Mfg. Co. for manufacturing purposes. Metzger & Greeneld are the architects.

LYNCHBURG, VA.—The Light Committee of the City Council held a meeting and decided to report in favor of accepting the proposition of the Electric Company, with some slight changes. The company owns the car line, the electric plant and water power at Reusens.

ALLEGHENY, PA.—The Westinghouse Electric & Manufacturing Company is about to establish another large industry in this section. The company will quickly build a 14-pot glass furnace on Lacock street, Allegheny, and is going into the business of incandescent lamp making on an extensive scale.

FREMONT, OHIO.—The city's contract for electric lighting will expire the first day of January, and the light committee was instructed to advertise for bids for lighting the city with electricity from that date for a period of five to ten years. The Council hopes to be able to secure cheaper and better lights.

GRAND RAPIDS, MICH.—Sealed proposals will be received until October 27, 1894, for lighting the city of Gand Rapids with electricity by means of 280 arc lamps of 2,000-candle power each, distributed on towers and individually. Joseph Emmer, W. T. Johnson and O. A. Ball are the Committee on Lamps.

SACRAMENTO, CAL.—The contracts for the Folsom-Sacramento transmission plant have finally been signed, and the work of construction will be pushed with all rapidity. Messrs. Hasson & Hunt, of San Francisco, are the advisory engineers, and the General Electric Company the contractors for machinery and construction.

ELBERTON, GA.—The city contemplates erecting an electric light plant and water-works system, and a mass meeting of citizens has been held in regard to an issue of bonds for $5,000. The Council has been ordered to call an election within 30 days to decide as to the issue of bonds. Address the Mayor or W. B. Henry, Clerk of the Council.

BRADFORD, PA.—The committee to inquire into the construction of an electric light plant reported favorably, with estimates for a sufficient plant for $25,000, ample to run 150 arc lights of 2,000-candle power. A resolution was offered asking the Mayor to issue a proclamation for a vote on some bonds to erect the plant, the vote to be taken at the February election.

MT. MORRIS, N. Y.—Several notes which have appeared in this department in regard to an electric lighting plant to be established at Mt. Morris may have conveyed a wrong impression in regard to the success of the company now possessing franchise there—the Mt. Morris Illuminating Company. The plant referred to in the notes, however, is the one to be installed for lighting the buildings of the State Epileptic Colony, the satisfactory service of the Illuminating Company precluding any thought of establishing a rival to it.

THE ELECTRIC RAILWAY.

ST. GEORGE, S. I., N. Y.—It is believed that Mr. Howard Carroll intends to build a trolley road on Staten Island.

GENEVA, N. Y.—It is reported that work of constructing the Geneva & Waterloo Electric railway is very soon to begin.

MOBILE, ALA.—The Mobile Light & Railway Company has closed a contract with the General Electric Company for a 120-kw monocyclic generator and an arc dynamo.

PLATTSBURGH, N. Y.—Mr. Norton contemplates the construction of a street railway system between Hotel Champlain and the Normal School, with numerous branches.

SHERMAN, TEXAS.—It is stated that the College Park Rapid Transit Company has sold its electrical railroad to a syndicate, which will build ten miles of additional road.

NEW HAVEN, CONN.—The petition of the Manufacturers Railroad Company for permission to operate a road by electricity through James street was referred to the committee on streets.

WASHINGTON, D. C.—A new street car line is badly needed. The route would be out 17th street to Lowell on Park street, and along Lowell to the entrance to the "Zoo" Park.

COUNCIL BLUFFS, IOWA.—The Council Bluffs Manawa Electric Railway Company received a franchise from the Manawa Council for right-of-way over all the streets and alleys in the town.

WILMERDING, PA.—The borough council of Wilmerding has granted right of way through the borough to the Turtle Creek Valley Electric Railway Co., to connect Wilmerding and McKeesport.

PHILADELPHIA, PA.—A car stable and power house, 100x500 feet in size, will be built for the People's Passenger Railway Company, near Carpenter Station, Mt. Airy, by Contractor Chas. McCaul.

PIKESVILLE, MD.—The Pikesville, Reisterstown & Emory Grove Railway Company has secured the right-of-way to construct a single track electric railway on the turnpike from Pikesville to Reisterstown, a distance of about 12 miles.

PORT BYRON, N. Y.—The electric road from Port Byron to Auburn now seems to be an assured fact. Eastern capitalists have taken hold of the mattter and have looked over the proposed route. Work will probably begin in the spring.

PITTSBURG, PA.—The Committee on Corporations of the Council recommended an ordinance granting right-of-way to the Pittsburg & Birmingham Passenger Railway to extend its line on Carson street east from the present terminus.

HACKENSACK, N. J.—The proposition of the Bergen Turnpike Company to build a trolley line in Hackensack has been disturbing the people. The town authorities purpose contesting the right of the company, which is expected to make a sharp contest.

DOYLESTOWN, VA.—Will m Jenks, Marshall S. Lynch, Robert C. Fulton

and Samuel A. Hamilton, of the Bucks County Trolley Company, have made application for a charter for an intended corporation to be called the Delaware & Schuylkill Traction Company.

SYRACUSE, N. Y.—The contract for lighting the city is held by the Syracuse Electric Light and Power Co. and will not expire until April 21st of next year. Several of the officers of the present administration declare that the rate of 30 cents per lamp is exceedingly low.

CORTLAND, N. Y.—At a meeting of the directors of the electric railroad, the contract for erecting the new power-house was awarded to J. S. Ball. Ground has been broken. The power-house will have four 150-hp engines of the compound condensing type and four 150-hp power boilers.

JAMAICA, L. I., N. Y.—The Long Island Electric Railroad Co. and the trustees of the village of Jamaica have at last come to an agreement as to the terms of a franchise asked for by the company to operate an electric railroad on certain streets of the village. The president is A. R. Hart.

PHILADELPHIA, PA.—Paul R. Smith, of Philadelphia, representing a number of Philadelphia capitalists, is negotiating for the purchase of the stock of the Perkiomen & Reading turnpike, with the view of building an electric railway line from Philadelphia to Reading. The price offered for the stock is $81,000.

BATAVIA, N. Y.—A new electric railroad on the bicycle system is to be built from Batavia to Lake Side, N. Y., passing through Medina and Waterport. It is said that the new company will construct a dam at Oak Orchard Creek, from which will be obtained the water power for the generation of electricity With which to propel the cars.

MIDDLETOWN, CONN.—It is now definitely stated that the electric road pormised so long is to be commenced at once. Isreal A. Telsey, of New Haven, and Mr. Pond, of New York, who owns the electric road in New Haven, are now the owners of the controlling amount of stock in this road. The capital stock is $50,000.

PROVIDENCE, R. I.—The Council has granted permission to the Providence Cable Tramway Company to substitute electric motive power for its present cable system. The change includes the adoption of a counter weight on the steep grade of College street, the descending cars pulling up a weight which assists to pull up the ascending cars.

BALLSTON, N. Y.—Stephen C. Nedbery, cashier of the First National Bank, and Herbert C. Westcott, secretary of the Ballston Electric Light & Power Company, have applied to the trustees for a franchise to build and maintain an electric railway within the corporate limits of Ballston Spa, the objective point being Rock City Falls. If granted the road will be built by June next.

NORFOLK, VA.—The Norfolk & Atlantic City Terminal Co., of which Mr. Joseph T. Allyn is president, has submitted a petition and ordinance to the Council asking permission to run a railway, whose motive power will be either electricity or horses, through several of the streets of the city. The whole matter was referred to a special committee consisting of Messrs. Sheldon, Brickhouse and Collins.

SOUTH ORANGE, N. J.—Petitions were received by the South Orange Township Committee from street railway companies, asking for franchises to operate a trolley line on Springfield avenue, between Irvington and Millburn. The New York & Philadelphia Traction Company's application was laid on the table, being reported as not properly presented. The Northern New Jersey Company's application was received and will be considered at a public meeting October 25.

LANCASTER, PA.—At a meeting of the Council Mr. Dinan presented an ordinance, which was referred to the Street Committee, granting the Lancaster City Street Railway Company the right and privilege to make extensions of its railway tracks and to operate motor cars thereon, and granting permission to the Lancaster Railway Company and the Lancaster & Terre Hill Railway Company the right to run their cars over the tracks of the Lancaster City Street Railway Company within the city limits, and to erect and maintain poles on certain streets.

Miscellaneous Notes

MR. JOHN BECK INGHAM, the well-known Philadelphia contractor, was married to Miss Emma L. Stephens, on October 10, at the bride's residence, Fairmount avenue, Philadelphia.

PATENT LITIGATION.—The Westinghouse Electric and Manufacturing Company has sued the Fort Wayne Electric Company for infringing since December 12, 1890, a number of its patents.

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES will inaugurate its 1894-95 course in the Department of Electricity on October 15, with a lecture on "Electricity and Its Applications in the Arts and Sciences," the first of eight illustrated lectures by Prof. Anthony, to be delivered in the lecture room of the Edison Electric Illuminating Company, 360 Pearl street, Brooklyn. A special course in electrical technology, with laboratory exercises and practical work, will be given at the same place; there will be 24 of these latter, the subscription to be $8.00 for the course.

THE FRANKLIN INSTITUTE, Philadelphia, announces the following programme of lectures on electrical subjects for the season 1894-95: Friday, Nov. 30, Mr. Louis J. Matos, Chemical Engineer, Chemist to the Falls of Schuylkill Carpet and Plush Mills, Philadelphia, "The Application of Electricity to the bleaching of Textile Fibres"; Friday, Feb. 1, Prof. Joseph W Richards, Ph. D., Lehigh University, Bethlehem, Pa., "Recent Progress in Electro-Chemistry"; Friday, March 15, Mr. Alexander Jay Wurts, Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., "Lightning Arresters"; Friday, March 22, Mr. A. E. Kennelly, F. R. A. S., Philadelphia, "Submarine Telegraphy"; Friday, March 29, Mr. Thomas Commerford Martin, New York, "Niagara on Tap".

THE NATIONAL SCHOOL OF ELECTRICITY has just established headquarters in New York City at the Decker Building, Union Square. Classes will be organized at several points in the city, as well as in Brooklyn and surrounding towns. Another office has been opened in Philadelphia in the Drexel Building, and within a few days a Boston office will be opened. From the Western office at Chicago classes have been organized in seven Western and Middle States, aggregating in membership something over fifteen hundred students. Considerable misconception seems to prevail in regard to the teaching faculty of the National School of Electricity, owing to an ambiguity in the published announcement. Tesla, Edison, Carhart, Anthony, Ryan and other names eminent in electrical science are announced simply as the "Faculty," and several youths who have called at the office of The Electrical World for information were under the impression that these gentlemen would be the actual teachers, which also seems to be the impression of some newspaper writers. We understand that the faculty named is an honorary body, though some of its members will prepare the lesson sheets in departments assigned to them.

TESLA AND THE NIAGARA PLANT.—A writer in the current number of "McClure's Magazine," in an article on "The Capture of Niagara," ascribes the success of the efforts to interest capital in the development of electrical power from Niagara Falls to Nikola Tesla. In regard to the many problems at issue the article states, after paying a tribute to Lord Kelvin, Dr. Sellers and Clement Herschell, that "the problem was, perhaps, not wholly solved in theoretical demonstration until Nicola Tesla, that illuminating wizard of electricity, persuaded these capitalists that he had discovered and, in great measure, perfected mechanical appliances which would make it possible to deliver the electric current, under complete control, and without costly loss from waste, a long distance; certainly as far as Buffalo and Rochester, and, as he himself firmly believed, as far as Albany, three hundred miles away. Mr. Tesla also has faith that, with the improvements suggested by experience, it will be possible by and by to deliver the current at fairly competitive prices as far away as New York city on the east, and as Cleveland and other of the greater towns in Ohio on the west. He has assured the company that, by means of inventions and scientific application of newly discovered principles which he has been able to make, it will be possible to convey the current without any very great loss by induction or leakage, and under absolute control, by the use of certain transformers, as far east as Albany. It is Mr. Tesla's opinion that this current can be sufficiently utilized even to propel vessels from Albany to New York. The capitalists have faith in him. The scientists believe that he is right. The city of Buffalo is persuaded that it is so, and already contracts for the delivery of as much as ten thousand horse power to the city have been made." The same writer says that "we cannot know, in fact, whether the electric current can be delivered with commercial profit to any considerable distance from the plant until the turbine wheels are actually started, their colossal power is delivered to the dynamos, and, after being by them converted into electricity, is conveyed thence to the testing points. The scientific world is awaiting these experimental tests as it awaited the first flashing of the message through the Atlantic cable; and the world of commerce and manufacture is awating them with no less interest."

Trade and Industrial Notes.

M. E. AUSTIN, formerly of the Knapp Electrical Works, Chicago, has been appointed western agent for Holmes, Booth & Haydens and the Safety Insulated Wire and Cable Company.

MESSRS. G. M. ANGIER & CO., New England contractors for the Mather Electric Company, have removed their offices from 116 Bedford street to 64 Federal street, Boston, Mass., where they have secured a suite of offices far more suitable for their business than at the old quarters.

MR. W. J. MAC CONNELL, formerly of Baltimore office of the General Electric Company, has resigned his position with that company to take the Eastern agency of the American Electrical Manufacturing Company, of St. Louis, with headquarters in Havemeyer Building, 26 Cortlandt street.

W. A. HALLER, First National Bank Building, Pittsburg, Pa., informs us that he was the contractor for the plant on board the coal boat "Robert Jenkins" described in The Electrical World of September 22. We regret that the name of Mr. Haller was inadvertently omitted from the article.

THE DETROIT MOTOR COMPANY, 1,343 Cass avenue, Detroit, Mich., sends us a handsomely executed catalogue devoted to the well-known Detroit motor. Different parts of the motor are illustrated by excellent wood cuts, as well as the automatic switch used with them, which entirely obviates any possibility of a burn-out.

THE MATHER ELECTRIC COMPANY, of Manchester, Conn., reports the closing of a second contract with the Hartford & West Hartford Horse Railway Company, Hartford, Conn., for two of their 180-kw railway generators with new Mather station equipment, the first generator, which was installed a few weeks ago, having given great satisfaction.

THE P.-W. STORAGE BATTERY COMPANY, of which R. Parsons, Son & Co., 173 Euclid avenue, Cleveland, Ohio, are general agents, has issued a 16-page pamphlet descriptive of the P.-W. storage battery and its uses. Illustrations of the battery and accessories are given, and the advantages of the Warwick plate and its applications are enumerated at length.

THE COOPER-ROBERTS COMPANY, Mt. Vernon, Ohio, reports the following recent sales of its high speed automatic engine: 40-hp to Barkhurst & Craven, Dillonvale, Ohio; 100-hp to Morris Coal Company, Sand Run, Ohio; 80-hp to Southwestern Virginia Improvement Company, Pocahontas, Va.; 80-hp to Chagrin Falls Electric Light Company, Chagrin Falls, Ohio; 150-hp to the Jeffrey Manufacturing Company, Columbus, Ohio; and one 40-hp, one 80-hp and one 110-hp for the Odd Fellows Hall, Philadelphia, Pa. T. T. Burchfield & Co., 55 North Seventh street, are the Philadelphia representatives of the Cooper-Roberts Company.

EUGENE MUNSELL & CO., 218 Water street, New York, have issued their new price list of electrical mica, arranged in a very convenient form. Each different size and grade is accompanied by a telegraph code word, of which there are over 300. In addition to the ordinary cut mica, we find India and amber sheet mica, stamped solid sheet mica segments for commutators, in fact, mica for every conceivable electrical use.

THE WESTERN ELECTRIC COMPANY, Chicago, has just issued a catalogue of street railway supplies comprising 98 large pages of descriptions and illustrations of every variety of line, power-house and motor material. Each item has a telegraph code letter affixed, thus greatly facilitating ordering in an emergency. The book is well printed on an extra quality of paper, and should be on the desk of every street railway superintendent and purchasing agent.

THE FIBERITE COMPANY, Mechanicsville, N. Y., will have two handsome exhibits of its well-known Medbery insulation at the forthcoming Street Railway Convention at Atlanta, one in the private parlor of the Mason Electric Company in the Hotel Aragon, and the other in the convention hall. The exhibits will be in charge of Messrs. H. J. Medbery, of The Fiberite Company; W. R. Mason, of Chicago, and F. H. Stacy, of the Hubley Manufacturing Company, of Lancaster, Pa.

A. O. SCHOONMAKER, 158 William street, New York, in a recent circular calls attention to the superior qualities of India solid sheet mica. To have the best and most satisfactory results mica should be used in its native condition, that is, in the solid sheet as it is mined, and it is only in this form that Mr. Shoonmaker handles it. The mica he sells comes direct from the original sources in India, and is perfectly free from iron, thus rendering its non-conducting properties of the very highest order, while it splits even throughout with a uniform smooth cleavage.

EDGAR ALLEN & CO., (Limited), Imperial Steel Works, Sheffield, England, send us a large-page pamphlet containing reports and permeability curves by Profs. Ewing and Jameson and Mr. Gesbert Kapp, relating to Imperial dynamo magnet steel castings. A number of curves to a large scale are included, showing the extraordinary good permeability and hysteretic qualities of this material. A working induction of 18 kilogausses can be reached and the ampere-turns for all working inductions are less than for wrought iron. The numerous curves will be found of value for comparative purposes.

THE IMPERIAL ELECTRIC LAMP COMPANY, 253 Broadway (Postal Telegraph Building), New York, has received flattering evidence of the efficiency of the Imperial arc lamp. The use of it by, and the recommendation of, such companies as the Royal and Hartford and Underwriters Insurance Companies, such hotels as the St. Cloud, Renaissance and Barrett House, such a printing house as the Fox, and such a dry goods store as that of Ehrich Bros., must mean more than usual in these days of competition and strife after superiority. The Imperial Company claims that only after a most exhaustive competition did it succeed in capturing the above business.

THE LOUISVILLE ELECTRICAL WORKS, located at No. 148 Fifth street, Louisville, Ky., is a new concern embarking in business as manufacturers of electrical and mechanical specialties, repairers of electrical apparatus and machinists. Mr. Campbell Scott, formerly president of the Southern Engineering Company, is the general manager, and they have fitted up a model factory in a large three-story building with a fine equipment of modern machinery, and are already working a full force of competent men. Besides doing all classes of electrical repair work, building and refilling commutators, etc., they will make a business of model making, manufacturing special apparatus, devices and appliances to order, and brass working. They are desirous of hearing from inventors who have practical, useful and saleable specialties which they desire manufactured.

THE MICA INSULATOR COMPANY, 218 Water street, New York, has issued useful instructions for the process of refilling commutators, as follows: "After assembling the commutator, heat it to about 200° F., or just enough to make the micanite pliable, then tighten the bars or ring as much as possible. The pliability of the micanite will allow the distribution of unequal strains and will counteract to a great extent irregularities in the dimensions of other parts of the commutator. Then continue the heating, but this time let it reach 400° F., or until the shellac, which will have oozed out here and there, has become dry. In fact the shellac may be partially carbonized with no bad results. Then retighten the commutator, either hot or cold, but preferably in both states. Do not tighten during the progress of this second heating, but wait until the shellac is baked dry. When no proper arrangements are provided for heating, the commutator can be put for a few minutes inside a boiler furnace door, or on a gasoline stove, or on a plate placed over a blacksmith's forge.

THE MOORE ELECTRICAL COMPANY has been incorporated under the laws of New York State, the directors being Leopold Wallach, the prominent counsel for several Trunk lines; Joseph Livingstone, the banker: Edward J. Wessels, general manager of the Genett Air Brake Company; and Mr. D. McFarlane Moore, the inventor. Neither Mr. Wessels nor Mr. Moore needs an introduction to our readers, as their work is well known. Mr. Moore's claims concerning current control and phosphorescent light have been made public in all the scientific and daily papers in this country and abroad, since the time when he read his paper before the American Institute of Electrical Engineers on "A New Method of Current Control." For the past five years Mr. Moore was an engineer for the Edison, Thompson, Thompson-Houston and General Electric Companies. On October 1 he tendered his resignation and is now devoting his entire energies to developing the business of the Moore Electrical Company under agreement with them. The new company has secured all the patents owned jointly by Messrs. Wessels and Moore, and an excellent laboratory has been placed at Mr. Moore's disposal.

THE FERRACUTE MACHINE COMPANY, manufacturers of presses and dies, Bridgetown, N. J., is now quite busy in its shops, having work in for five or six weeks ahead and running full time. It is building a number of presses which are especially adapted for electrical work. It has recently sent quite an outfit to the Jeffrey Manufacturing Company, of Columbus, Ohio, consisting of a large double column press, with round bed and several pairs dies for cutting armature discs. Also a special punching press with universal indexing attachment for notching armature discs. This machine will punch any number of notches in the disc from 4" to 36" diameter. It has sold several of them to other electrical firms and they have proved very popular. It is now building a very large press for the General Electric Company, of Schnectady, the weight to be about 20,000 pounds. Three of these presses are already in use in Schnectady, and are very satisfactory. It is also building a number of cutting and punching presses for various other work, and some special machinery for the Standard Oil Company. It is building a large line of presses, some 300 different kinds, and these are all from new designs, and with various improvements in their clutches, adjustments, etc. It has just shipped a very handsome press with double feed attachment, gang dies, etc., to the Frankford Arsenal, Bridesburg, Philadelphia, for making cartridge shells.

TAYLOR, DEE & MACK, 320 Dearborn street, Chicago, on October 1 made an assignment for the benefit of their creditors. Continued depression in business circles and the expressed wish of one of the partners to withdraw from the firm made an assignment necessary as the only way to adjust matters between creditors and members of the firm, without running the risk of further complications. A mee ing of creditors was therefore called for Wednesday, Oct. 3d, when a statement was made of the affairs of the company, the members of which expressed themselves as wishing to settle on a basis of one hundred cents on the dollar. It was shown that the estate could not pay that amount if closed out at once, but a proposition was made either to continue the business in the interest of the creditors until all claims were paid in full or to close out the estate at once, in which event Messrs. Taylor & Dee expressed a willingness to assume and pay up at as early a date as possible all claims not paid in full out of the proceeds of the estate. A committee of creditors was appointed to examine into the affairs of the company and report at a meeting of creditors to be held on the 6th. The committee reported that they found the statement made by Messrs. Taylor & Dee to be practically correct, and recommended that the business be continued under the assignee, for the present at least. The troubles of the firm may be laid to a wrong start, capital having been promised which was never paid in. Lack of sufficient capital led to troubles of various kinds, which finally culminated in the assignment. Messrs. Taylor & Dee express confidence in their abilty to finally pay all claims in full.

Business Notices

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED OCTOBER 9, 1894.

(In charge of Wm. A. Rosenbaum, 177 Times Building, New York.)

527,066. DEVICE FOR PROTECTING SEPARATELY EXCITED GENERATORS; B. G. Lamme, Pittsburg, Pa. Application filed February 28, 1894. This comprises a nominally closed break common to both armature and field magnet circuit thereof, and means for opening the break.

527,070. ELECTRICAL CONVERTER; J. W. Packard, Warren, Ohio. Application filed January 3, 1894. A converter having a primary coil, a secondary coil, and a cylinder or double ring enclosing both coils and composed of alternately arranged plates having their internal portions of unequal width.

527,071. ELECTRICAL FUSE BOX; J. W. Packard, Warren, Ohio. Application filed January 3, 1894. This comprises a core having a block at each end, one of the blocks having projecting portions in engagement with a contact ring on the box, and a spring bearing against the core and forming contact between it and the block on the box.

527,075. RUNNING COMPOUND WOUND DYNAMO ELECTRIC MACHINES IN MULTIPLE; W. B. Potter, Schenectady, N. Y. Application filed June 2, 1894. This consists in energizing the series coil of the idle machine with current from the other machines, to acquire a prelminary magnetization.

527,092. CIRCUIT CONTROLLER FOR REGULATORS; B. B. Ward, New York, N. Y. Application filed October 13, 1893. The combination with a fixed contact of a movable contact, an expanding and contracting member connected to the movable contact, and a magnet for retaining the contacts in engagement during a predetermined interval.

527,098. RAILWAY ANNUNCIATOR; C. R. Alsop, Middletown, Conn. Application filed November 2, 1893. This comprises electro-magnets, an indicating hand, an alarm circuit, and a separate hand-operated mechanical releasing device for releasing the indicating hand from either magnet.

527,099. ELECTRIC TRACK SIGNAL; C. R. Alsop, Middletown, Conn. Application filed November 27, 1893. This comprises contact springs, a signal circuit and a horizontal spring-actuated contact lever mounted to play on a vertical pivot adjacent to one side of the track rail and normally out of contact therewith, to leave a space of less width than a car wheel flange, which is adapted to move the contact lever laterally between the contact springs.

527,114. TELEPHONE TRANSMITTER; T. McCoubray, New York, N. Y. Application filed Aug. 16, 1894. A telephonic transmitter provided with comminuted or powdered conducting material held in place by two disks having spirally corrugated surfaces.

527,126. ELECTRIC LOCOMOTIVE; N. J. Raffard, Paris, France. Application filed July 23, 1891. An electric motor surrounding the axle and having multi-polar field magnets presented endwise to the armature, and having an armature of the full diameter of the motor.

527,127. COMMUTATOR BRUSH HOLDER; G. Rauch, Milwaukee, Wis. Application filed April 28, 1894. An insulating base, longitudinally adjustabl sleeves, shells adjustable in the sleeves transversely of the base, a binding post and brush guide on each shell, and a crab that has one arm under spring tension within the shell and its other arm loosely engaging with the adjacent brush guide.

527,150. ELECTRIC OR AMALGAMATING APPARATUS; J. C. Ludwig, San Francisco, Cal. Application filed March 5, 1894. This comprises a sluice-box, a metallic plate having pockets on its surface, a swinging frame, and means to connect the frame with one pole of an electric generator, an apron attached to one end to the swinging frame and covering the surface of the metallic plate and means for connecting to the plate a conductor from the other pole of the generator.

527,177 ELECTRIC SWITCH; R. S. Kelsch, Chicago, Ill. Application filed May 28, 1894. This comprises a support, loop line conductors and main line conductors, and a switch bar provided with ferrules separated by an insulating space.

527,195. ALTERNATING CURRENT MOTOR; C. Coerper, Cologne, Germany. Application filed May 15, 1894. The combination of an armature provided with unwound radial arms, and field magnets composed of two semi-circular sections having inwardly projecting pole pieces at the ends thereof, every two adjacent poles of which act simultaneously on adjacent arms of the armature.

527,211. ELECTRIC CAR LAMP; M. Mayer, New York, N. Y. Application filed June 18, 1894. This comprises an inverted base and a hanging glass connected at its upper edge to the base, carbons and converging carbon holders, means for feeding the carbons with uniformity in one pair of holders, and an electro-magnet and connections for acting on the other carbon in drawing the arc.

527,225. ADJUSTER FOR FIELD MAGNETS OF DYNAMO ELECTRIC MACHINES OR MOTORS; M. Waddell, Bridgeport, Conn. Application filed September 6, 1893. This comprises a perforated frame, fastening devices extending through the perforations to support the field magnets, and a support mounted on the frame carrying the adjusting devices upon which the field magnets rest.

527,228. ELECTRIC ARC LAMP; J. E. Woolverton, New York, N. Y. Application filed Feb. 9, 1894. Rigid tubular carbon holders converging, in combination with sliding socket within the same for the reception of carbons, lazy-tongs connections for feeding the carbons, a second pair of carbon holders, sockets and lazy-tongs mechanism and means for moving one pair of carbon holders in relation to the other pair for forming the electric arc.

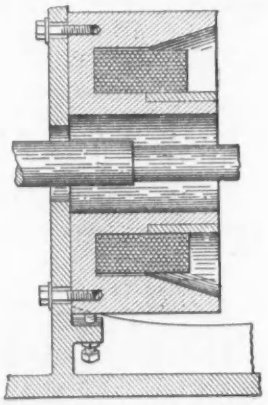
527,229. ELECTRIC ARC LAMP; J. E. Woolverton, New York, N.Y. Application filed April, 13, 1894. This comprises two fixed covering tubular carbon holders slotted longitudinally throughout their length, carbon receiving sockets movable longitudinally in the holders, an arc frame and guide bar rigidly supported and connected with the carbon holders, a tube sliding on the guide bar and having a T head and hinged links extending from the T head to the sockets.

527,244. ELECTRIC LOCOMOTION ON RAILWAYS; J. J. Heilman, Paris, France. Application filed April 20, 1894. The combination with a main dynamo driven by an engine having a fixed cut-off of an exciting dynamo driven by a separate engine and a rheostat for varying the current supplied by the exciter to the field magnets.

527,254. INSULATOR; W. D. Trimble, Baltimnore, Md. Application filed Feb. 2, 1894. This comprises an upper piece having a socket closed on all vertical sides and open on the bottom and provided with notches in its side flanges; and a clamping piece provided with notches and fitting up within the socket so that the latter projects down around it on all sides.

527,257. ELECTRIC SIGNAL; H. H Wister, Colorado City, Col. Application filed April 10, 1893. This comprises an insulated rim elastically attached to the wheel of a vehicle and adapted to engage an auxiliary rail, the wheel connected with one pole of a battery and the rim with the other pole.

527,258. SIGNAL RECORDING DEVICE; W. H. Adkins, Rome, Ga. Application filed December 22, 1893. The combination of a rotary recording disk, a



NO. 527,225.—ADJUSTER FOR FIELD MAGNETS.

sliding carriage carrying a magnet and its armature, a pencil holder carried by the armature, a motor for rotating the disk and actuating the carriage, and an electric starting device for the motor connected in series with the magnet actuating the pencil holder.

527,265. CONDUIT SYSTEM FOR ELECTRIC RAILWAYS; W. A. Butler, New York, N. Y. Application filed April 20, 1894. This comprises a conduit' main conductor therein, a series of brackets, each having a coupling box through which the main conductor pas es, and a contact box consisting of a closed inner shell, a rocking closed outer shell, a conductor or contact projecting from the outer shell and controlling the contact within the inner shell, and a contact device carried by the car adapted to rock the outer shell to complete the circut.

527,267. SYSTEM OF ELECTRICAL BLOCK SIGNALS FOR RAILWAYS; W. M. Cuthbert, Brooklyn, N. Y. Application filed February 16, 1893. This comprises a signal post, means operated by a passing train for setting a signal, a stop for holding the signal when so set, a foreign battery, a primary open circuit and cricuit closer, a secondary open circuit and battery, a relay magnet and electro-magnets for releasing a set signal.

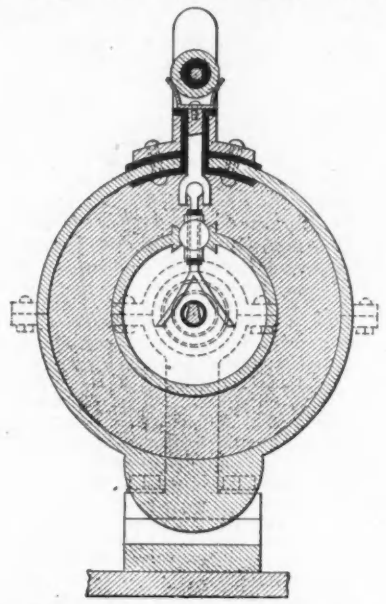
527,285. INCANDESCENT LAMP SOCKET; L. R. Peck, St. Johns, Mich. Application filed April 10, 1894. A switch block having a wall or diaphragm, upon opposite sides of which the terminals are adapted to be secured.

527,294. TRACK SWITCH FOR ELECTRIC RAILWAYS; A. F. Schinner, Milwaukee, Wis. Application filed June 16, 1894. A switch operating mechanism operated by the core of the magnets, and a single insulated strip of wire completing the circuit of the magnets, whereby when contact is made therewith by the trolley the switch point will be thrown in one direction, and when contact is made by the next trolley will be returned.

527,298. ELECTRIC BATTERY; M. E. Smith and M. F. Greer, Rochester, N. Y. Application filed March 29, 1894. This coprimses a jar, a negative electrode extending into the fluid contained in the jar, a porous cup held in the jar and extending into the fluid, a positive electrode held in the porous cup, and an exciting fluid in the porous cup, the fluid containing chromic acid.

527,301. CONDUIT ELECTRIC RAILWAY; J. E. Toole, Northumberland, Pa. Application filed January 24,1894. This comprises a conduit having a slotted bottom and meeting ribs, insulators dovetailed into the ribs and adapted to the line wire.

57,304. WORKMAN'S TIME RECORDER; E. G. Watkins, Gardner, Mass. Application filed July 22, 1893. The combination of a cylinder carrying the time sheet, a marking mechanism, a screw adapted to rotate with the cylin-



NO. 527,265.—CONDUIT SYSTEM FOR ELECTRIC RAILWAYS.

der, and a stationary screw threaded bearing for supporting the screw, whereby the cylinder is displaced axially during its rotation.

527,317. INSULATOR; E. J. Bullock, Wallingford, Conn. Application filed November 27, 1893. An insulator having a body provided with an annular recess, a removable head applied to the body, and a metal wearing surface located in the recess.

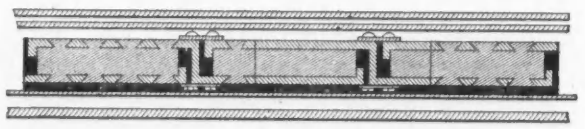
527,318. INSULATOR PIN; E. J. Bullock, Wallingford, Conn. Application filed February 9, 1894. An insulator having a longitudinal bore, a metal reinforce therein, but shorter than the length thereof, and plug fitted tightly in the open end of the bore over the outer end of the reinforce and sealing the same within the pin.

527,255. TROLLEY WIRE SUPPORT OR HANGER; S. C. Woodhead, Philadelphia, Pa. Application filed April 24, 1894. This comprises a spindle having a hook at one end and at its other a riveted head, a wire support adapted to revolve around the spindle, and wire radial arms attached to the wire support.

527,375. THERMOSTAT; L. G. Rowland, Camden, N. J. Application filed June 5, 1893. This comprises contact points, a spring pressed rod, a contact plate carried thereby, a removable nut attached to the rod, the nut having a slotted end, and a fusion plate attached to the nut.

527,377. APPARATUS FOR MOUNTING AND OPERATING THERMO-PILES; M. L. Severy, Boston, Mass. Application filed February 16, 1894. The combination of a frame, trunnions on each end of the same, vertical supports, thermo-piles, glass jacket, threaded rod pivoted to the side of the frame, a nut on the rod, and a cylinder pivoted to the support.

527,378. APPARATUS FOR UTILIZING STEAM FOR HEATING THERMO-PILES; M. L. Severy, Boston, Mass. Application filed February 16, 1894.



NO. 527, 379.—APPARATUS FOR GENERATING ELECTRICITY BY SOLAR HEAT.

The combination with a steam boiler and a thermo-pile, one face of which is heated by the exhaust steam and the other face cooled by the feed water supply.

527, 379. APPARATUS FOR GENERATING ELECTRICITY BY SOLAR HEAT; M. L. Severy, Boston, Mass. Application filed February 16, 1894. A thermo-electric pile operated by solar rays and means for constantly presenting the parts thereof to be heated towards the sun from sunrise to sunset at all seasons.

527,393. BUSY TEST FOR MULTIPLE SWITCH-BOARDS; R. H. Polk, Savannah, Ga. Application filed April 20, 1894. This comprises a high tension current source, a connecting loop, and a condenser of such capacity that the talking current will not pass through it, interposed in the wire connecting the source of curreut and loop, and a test plug circuit.